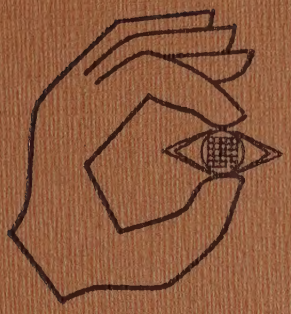

TELEQUIPMENT
OSCILLOSCOPE
SWEEP PLUG-IN

TYPE S 2A

MANUAL

TELEQUIPMENT

SWEEP PLUG - IN

TYPE S2A

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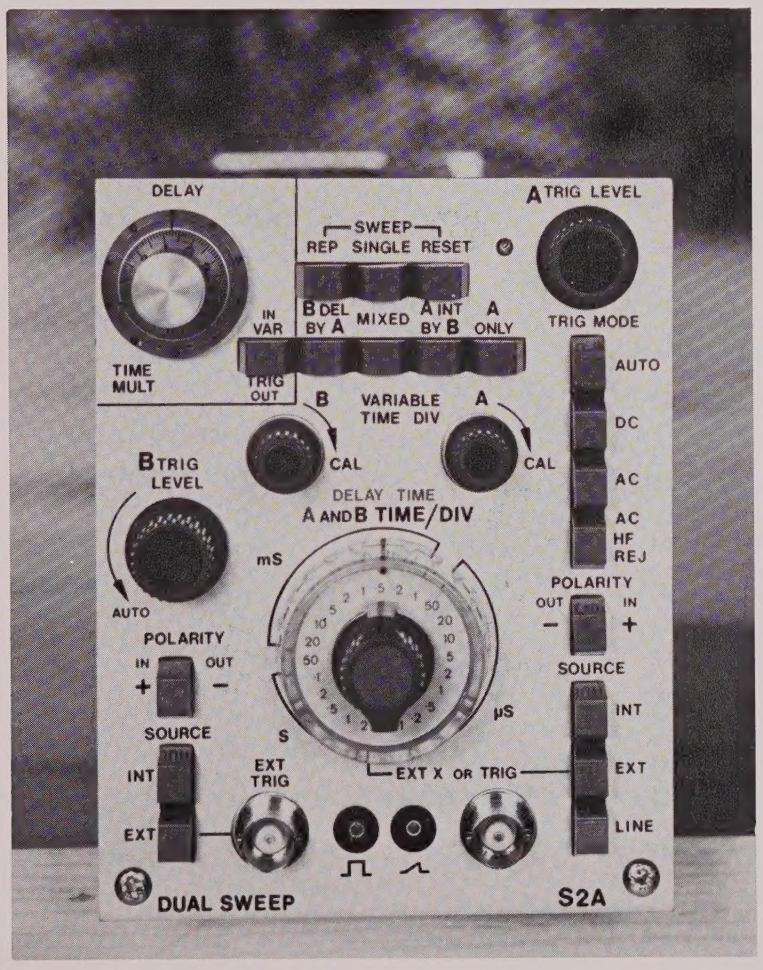
INTRODUCTION

The S2A, a dual sweep plug-in, provides the main frame with a delayed sweep facility to permit close examination of any part of a complex waveform and allows for an accurate time measurement of the input signals.

This manual should be read in conjunction with the plug-in manuals of the units used. References are annotated "MF" and "V" for the main frame and vertical plug-in respectively.

The design of this instrument is subject to continuous development and improvement, consequently this instrument may incorporate minor changes in detail from the information contained herein. This would, in the main, affect the Components List and Circuit Diagrams. The reader should pay particular attention to the notes at the beginning of Chapter 5.



NOTICE TO OWNER

To obviate the risk of damage during transit and facilitate packaging; do NOT send the following items unless they are suspect, should this Instrument be returned to TELEQUIPMENT for servicing.

Manual
Probes
Plug Assemblies

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CHAPTER 1
SPECIFICATION

1.1 OPERATING MODE

A Sweep — Repetitive or Single shot dependent on 'A'

A Intensified by B
B delayed by A
A and B Mixed
Delayed B
Variable
Triggered

1.2 TRIGGER

	A	B
Mode		
Auto	Bright line	10 Hz — 10 MHz freerun between 20 & 50 Hz
Level	40 Hz — 50 MHz	
DC	D.C. — 50 MHz	
AC	10 Hz — 50 MHz	
HF reject	10 kHz — 2·0 MHz (−3 dB)	
Sensitivity		
Internal		
L.F.	0·2 divisions	0·4 divisions
10 MHz	0·2 divisions	1 division
50 MHz	1 division	
External		
L.F.	300 mV	500 mV
10 MHz	300 mV	1 V
50 MHz	500 mV	
Polarity		
+	from positive signal edge	
−	from negative signal edge	
Source		
Internal	from vertical amplifier	
External	from external source	
Line	from power supply Transformer secondary	

1.3 SWEEP

Range	2 s — 100 ns/div	1 s — 100 ns/div
Variable (time)	>2·5 to 1	
X10 Speed	10 ns/div max.	
'A' & 'B' Mixed	The 'A' sweep as Time/Div, but the mixed portion sweep speed is calculated from speed $\left(\frac{B}{1 + B/A}\right)$	
Accuracy		
X1	±3%	
X10	±6%	
'A' & 'B' Mixed	The 'A' sweep accuracy is ± 3%. The mixed portion accuracy is ± 3% ± (B/A x 3) %	

1.4 EXT X

Sensitivity	
X1	400 mV/div ±15%
X10	40 mV/div ±20%
Bandwidth	>1 MHz

1.5 DELAY TIME MULTIPLIER

Accuracy	
Absolute	±1% of Total Delay + 450 ns max. } excluding sweep accuracy.
Incremental	±1% of Total Delay } excluding sweep accuracy.

CHAPTER 2

OPERATING INSTRUCTIONS

2.1 FUNCTION OF CONTROLS AND CONNECTORS

These are situated on the front panel except where otherwise specified. For those controls not covered below, reference should be made to Chapter 2 of the manuals for the main frame and "V" plug-in.

2.1.1 **CRT** "MF" Manual.

2.1.2 **SWEEP**

A & B TIME/DIV — controls the speed of the respective sweeps. The sweep rates indicated are only valid if VARIABLE is at CAL and X10 is not selected.
If X10 is selected and VARIABLE at CAL, the calibrations should be divided by 10 factor to ascertain the sweep speed.

A & B VARIABLE TIME/DIV — enables speeds between that indicated by the respective TIME/DIVs and the next lower speed to be selected.

REP — pressed, selects repetitive triggering.

SINGLE SHOT — assists in viewing or photographing a non-recurrent signal. If a recurrent signal is applied to the oscilloscope in the SINGLE-SHOT mode, the sweep will run once each time RESET is pressed. When a recurring signal is applied, the timebase should be locked by using LEVEL.

DELAY TIME MULT — varies the point on the 'A' sweep at which the 'B' sweep starts.

DELAY — used in conjunction with 'A INT BY B' or 'B DEL BY A.'
NOTE: For minimum delay jitter, TRIG mode should be used.

VARIABLE — starts the 'B' sweep at the point set by the DELAY TIME MULT, for closer investigation of any part of the waveform displayed.

TRIG — starts the 'B' sweep, on receipt of a suitable triggering signal, after the point set by the DELAY TIME MULT; which, when rotated, causes the bright-up to jump to the same position on the adjacent cycle. Also permits closer investigation of the waveform edge selected by POLARITY.

A ONLY — displays 'A' sweep, 'B' sweep is disabled.

A INT BY B — displays the trace with that part of 'A' sweep covered by 'B' intensified.

B DEL BY A — magnifies the intensified trace permitting closer investigation.

MIXED — pressed displays 'A' & 'B' mixed, the 'B' sweep calibration is affected. See para. 1.3.

2.1.3 **TRIGGER**

A TRIG LEVEL — selects that point on the signal waveform at which the A sweep starts.

TRIG MODE
AUTO — provides a bright line AUTO, permits the 'A' timebase to free run until signal is applied. LEVEL range is reduced to approximately 1 division.

AC or DC — relate to the coupling of the trigger circuit. For very low input frequency DC should be selected.

AC HF REJ. — rejects high-frequency signals, permitting the trigger to respond only to low-frequency components of the triggering signal.

POLARITY
± — selects triggering from the positive or negative-going slope of a waveform.

SOURCE
INT and EXT — enable the sweep to be triggered either, internally from the vertical amplifiers, or externally via panel BNC socket.

LINE — provides trigger signal at the power supply frequency.

B TRIG LEVEL — selects that point on the signal waveform at which the 'B' sweep starts.
In the AUTO position, the trigger oscillates at a low repetition rate in the absence of a triggering signal. When a suitable signal is applied, the circuit is automatically triggered at the mean level of the input waveform.

POLARITY }
SOURCE }

see above.

2.1.4 **VERTICAL**

"V" Manual.

2.1.5 **CONNECTORS**

INPUT

A EXT TRIG & EXT X

is the right hand BNC connector of the pair on the front panel. This enables either external triggering signals to be applied by selection adjacent EXT source button or in the EXT position of the 'B' TIME/DIV switch, provides the EXT X input. The connector is DC or AC coupled to both trigger and horizontal amplifier circuits.
Input resistance is 100 kΩ. For amplification of the horizontal display refer to "MF" Manual.

B EXT TRIG

is the left hand BNC connector of the pair on the front panel. This enables an external trigger signal to be AC connected to the 'B' Timebase.

OUTPUTS

SAWTOOTH

provides a positive-going ramp waveform when the 'A' sweep is running. A recurring sawtooth is produced when AUTO is selected.

GATE OUT

provides a fast-edged positive-going rectangular pulse lasting for the duration of the sweep.

2.2 PRE-OPERATIONAL CHECKS

Note: Reference should be made to the 'MF' and 'V' manuals for control setting and operation.

2.2.1 **POWER SUPPLY.** See 'MF' Manual.

2.2.2 **CONTROL SETTINGS**

1. CRT. See 'MF' Manual.
2. Set controls as follows:

SWEEP	REP
A ONLY	Depressed
TIME/DIV	5 ms
VARIABLE	Fully clockwise
TRIG MODE	Auto
POLARITY	Depressed
SOURCE	INT

2.3 OPERATION. See 'MF' Manual.

CHAPTER 3
CIRCUIT DESCRIPTION

3.1.0 GENERAL

3.1.1 The S2 dual sweep unit generates precision timing currents which, when applied to the sweep amplifier, reference Figure 2 and the bright-up amplifier, reference Figure 3, enable the CRT to display a highly accurate sweep of controlled intensity.

3.1.2 The unit consists of a master sweep current generator, known as the 'A' sweep and a subsidiary sweep current generator, the 'B' sweep, both incorporating an integral bright-up current generator. Individual trigger amplifiers are able to accept internal or external trigger signals, which control the start point of each sweep together with a comprehensive switching system to enable a wide variety of display modes to be selected by the user. The complete unit is constructed in modular form, all power supplies and signal outputs being transferred via a single 16 way edge connector extending to the rear of the plug-in.

3.2.0 'A' SWEEP TRIGGER AMPLIFIER

3.2.1 This amplifier can accept balanced trigger signals originating in the vertical amplifier system or single-ended external signals via a panel co-axial socket, SK1.

Balanced signals are fed into the trigger amplifier via a 150 Ω matched transmission line from the plug-in edge connexion part of PC133 then to the balanced trigger amplifier, TR3 and TR4, via D.C. blocking capacitors, C3 and C4, the INT/EXT, switch, S1, the POLARITY switch, S2, and terminating resistors, R13 and R31.

3.2.2 TR3 and TR4, form a long-tailed pair amplifier. When S3d is set to H.F. REJ., the amplifier gain commences to fall at frequencies above 2·0 MHz, making the circuit progressively unresponsive to H.F. signals. 'A' LEVEL, R22, alters the currents in TR3 and TR4 permitting the selection of any point on the trigger signal to be set at D.C. level, where the Schmitt amplifier TR6 and TR7 switches over.

In the AUTO position, R22 is shunted by D4, R19, R29 and D6 and R21 is connected in series with the wiper. The range of R22 is drastically reduced, thus enabling accurate setting of the trigger point for low amplitude signals. R26 is adjusted to give the correct output D.C. level with the TRIG LEVEL control in mid-position.

3.2.3 Following TR4, is a frequency compensated shunt feedback stage formed by TR5, R32, R33 and C13. R32 and C13 compensate for R23 and C11 in the emitter of TR3 and TR4 and give a flat frequency response but limit the output voltage swing at frequencies above 2 MHz. It is D.C. coupled via parasitic stoppers, R35 and C15 to the Schmitt trigger circuit TR6, TR7.

Normal dividing down action takes place between 2 and 10 MHz depending upon input amplitude. Two outputs are provided:—

(1) Fast negative spikes via C61 and D61 to the bright line monostable TR61 and TR62.

(2) Fast positive spikes via C64, L61 and D64 to the A sweep gating bistable TR63 and TR64.

3.2.4 Unbalanced trigger signals, originating from any external source, are applied to the sweep unit via co-axial socket SK1 at an input impedance of 100 kΩ. The trigger amplifier is responsive to both D.C. and A.C. signals. By operation of S3; the D.C. component of an A.C. signal to the peak value of 250 V may be blocked. TR1 and TR2 form a single-ended shunt feedback pair, the output of which may be directed into the trigger amplifier or the horizontal amplifier in the main frame. The latter is connected when the 'B' TIME/DIV Switch S251, is set to the extreme anti-clockwise position. In all other positions TR1 and TR2 output is connected to the trigger amplifier via S1b, S1a and S2.

R7 enables DC adjustment of the level of external signals to the same as that of internal signals. TR1 and TR2 supply voltage is derived from a twin zener regulator, D3 and D8, fed from the main +24 V line via R12.

3.2.5 In the EXT X position of the 'B' TIME/DIV. switch, TR3 and TR4 are disconnected from the −24 V line to prevent trigger signals from internal sources reaching the Schmitt amplifier. D5 permits current, from the +100 V and +24 V lines, to flow to ground.

3.3.0 'A' SWEEP GENERATOR

3.3.1 This system is a conventional Miller Integrator, TR66 and TR67, forming a basic ramp generator, reference Figure 2. Ramp slope is determined by selection of timing capacitors C275 to C279, C281 and C282 reference Figure 3 and timing resistors R276 to R283, R287 and R289 mounted on the 'A' TIME/DIV switch, S271; R191 provides calibration facilities.

3.3.2 Trigger pulses from the 'A' Trigger amplifier are passed through a differentiating network R41 and L61. D64, being marginally biassed in the conducting direction, permits the fast positive-going edges to be applied to TR63 collector and TR64 base via C66. Negative-going edges are rejected by diode action. TR63 and TR64 form a gating bistable.

During the WAIT period, when the sweep generator is receptive to trigger signals, TR63 is conducting and TR64 is off. The quiescent state of TR63 and TR64 is set by R73 which adjusts the bias of TR63 with respect to TR64. A positive spike being applied to TR64 causes it to conduct; the feedback action via the coupled emitter, R76 and C66, switches TR63 off. It's collector potential rises to reverse bias D64 and prevents further trigger pulses from entering the bistable and a positive-going gate pulse is made available at the front panel via socket SK61.

3.3.3 TR65 clamps the D.C. level from which the ramp commences.

The current flowing from TR65 collector, via D66, D69 and D71 to the timing resistors, is diverted through TR64, which reverse biases D66, D61 and D71 and allows the current through the timing resistors to flow into the timing capacitors.

3.3.4 The TR66 drain voltage then commences to rise linearly carrying TR67 base and emitter with it. A positive feedback to increase the loop gain is provided, via R99 and R96, thus improving ramp linearity by reducing the potential excursion at TR66 gate. The ramp voltage appearing at the emitter of TR67 is fed to the sweep-out circuit, reference Figure 5, via S271, S192 and SK271 on the front panel, to the hold-off bistable TR68 and TR69, via D73 and the parallel combination of C75 with R103, R104 and R105. TR69 is normally conducting, drawing part of its collector current through neon lamp V61, mounted on the front

panel, causing it to glow during the wait and sweep period.

3.3.5 The ramp terminates when TR68 base potential rises to the same value as TR69 base potential, switching TR68 on, TR69 off and extinguishing V61. TR69 no longer draws current via R118 and D75, causing D76 to conduct and turn on TR63. The two transistors switch back to the state prior to receiving a trigger pulse. Flyback current then flows from TR65 to the timing capacitors via D66, D69 and D71, causing the ramp voltage to return rapidly to the quiescent condition.

3.3.6 It is undesirable for the sweep to be triggered before flyback is completed, a time delay is achieved by selecting a suitable capacitor mounted on S271 reference Table, which holds in the off state, thus preventing TR64 being triggered to the conducting state. Hold-off capacitors C271 to C274 are charged during the sweep period via D73 and discharge during and after the flyback period via R103 to R106. R105 sets the sweep length. At the end of the hold-off period, TR69 conducts states, permitting the gating bistable, TR63 and TR64, to be receptive to a trigger signal which initiates another sweep.

3.4.0 BRIGHT-LINE AUTO

3.4.1 TR61 and TR62 form a monostable pair in which TR62 is normally conducting and TR61 is off. When S3a is in the non-auto position, D63 is back biassed and exerts no influence on the base bias of TR63.

3.4.2 In the AUTO position R68 is open circuited and the bias resistors, R72 and R73, are shunted by R65, which lowers TR63 base potential causing the sweep to run free, in the absence of trigger signals, giving visual indication of the trace position.

3.4.3 Upon the application of positive and negative trigger pulses from the 'A' Schmitt amplifier, via C61; D61 being marginally forward biassed accepts and passes negative pulses to TR61 base, positive pulses being blocked by diode action. A negative pulse applied to TR61 base, causes TR61 to conduct for a period determined by C63 and R67 before switching back. The mean current drawn by TR61 causes a potential rise across R65, smoothed by capacitor C62 to reverse bias D63 and prevent the gating bistable free running the 'A' sweep. In this condition the 'A' sweep is triggerable and the trace is locked to the input signal. D62 prevents TR61 bottoming during its conducting period ensuring an approximate cycling frequency of about 25 Hz.

3.5.0 UNBLANKING AMPLIFIER

3.5.1 The unblanking pulse amplifier is a current to voltage convertor or transimpedance amplifier. Current input source for this amplifier is provided by R89, R93 and R92. Prior to the initiation of the sweep, D67 is reverse biassed by D66; suppressing CRT beam current. At the commencement of sweep, D66 is reverse biassed permitting current from the unblanking amplifier to flow to the −24 V line via D67, R89 and D68. In the 'A INT BY B' position, an additional resistor R217, reference Figure 5, is switched in series to reduce slightly the current drawn through D67 and reduce the beam intensity, so that when the 'B' timebase sweeps, the full beam current is restored for the 'B' sweep period via D198, R222, D203, R218 and R198.

3.6.0 'B' SWEEP TRIGGER AMPLIFIER

3.6.1 This amplifier can accept balanced trigger signals originating in the vertical amplifier system or single-ended A.C. coupled external signals via a panel co-axial socket SK151.

3.6.2 Balanced signals are fed into a high impedance input from a balanced 150 Ω transmission line terminating at the 'A' trigger amplifier. C151 and C154 block the D.C. component and limit the low frequency response to approximately 3.5 Hz. When S152 is in the INT position, balanced signals are applied via POLARITY switch S151 to TR151 and TR152 bases, a frequency compensated long-tailed pair amplifier.

R153, connected between the +24 V line and ground, permits bias adjustment to TR151 thus enabling any point on the input signal to be aligned to the switch-over point of the 'B' Schmitt trigger, TR154 and TR155. TR153, R165, R166, R167 and R168 form a shunt feedback stage acting as a buffer amplifier between TR152 and TR154.

3.6.3 In the AUTO position the LEVEL control R153 is switched out of circuit and the output from TR155 collector is integrated by R174 and C157 and fed back to the base of TR153 via R165. The circuit then oscillates in the absence of trigger signals at a frequency of approximately 35 Hz. The base wave form of TR154 is triangular in shape and oscillates between the triggering levels of the Schmitt. The mark space ratio is adjusted to unity by R159 and the backlash set to 60 mV by R173.

3.6.4 External trigger signals from front panel socket SK151 are applied via S152 and R151 to the appropriate base of the trigger amplifier. The squarewave response is set up by adjustment of a twisted wire pair across R151.

3.7.0 'B' SWEEP GENERATOR

3.7.1 This system is a conventional Miller integrator TR196 and TR197 forming a basic ramp generator, reference Figure 5. The ramp slope is determined by selection of timing capacitors C251 to C257 reference Figure 3 and timing resistors R251 to R258 mounted on the 'B' TIME/DIV. switch S251. R236 provides a calibration facility. A close operational similarity exists with the 'A' ramp generator so a full description will not be necessary, except to note that the ramp is terminated by the zener diode D201 and flyback is delayed until the 'A' sweep flyback occurs.

3.7.2 Initiation of the 'B' ramp is dissimilar and totally dependent upon the presence of the 'A' sweep ramp. The 'A' ramp voltage, divided down by R191 and R193, is applied to TR191 base. TR191 and TR192 form a bistable, where TR191 is conducting initially. Conduction switch-over takes place when the divided-down 'A' ramp voltage at TR191 base is equal to the voltage of TR192 base, set by potential divider R199, a precision wirewound potentiometer on the front panel. At the instant of switch-over TR191 collector current falls rapidly and a negative-going voltage step is applied to TR193 via R206 and C196.

3.7.3 When S191a is in the VAR position, the D.C. bias on TR193 is such that the negative step applied causes to switch on TR193 and TR194 off. D195 anode potential falls towards the negative line as TR195 current is insufficient to sustain a high enough potential across R212 and R213 and is caught just below ground potential by D194, D196 and R197 and are instantly back biassed, TR196 through Miller action commences to generate the 'B' ramp voltage.

3.7.4 With S191a in the TRIG position, the slightly higher bias on TR193 base prevents conduction switch-over upon receipt of the negative step from TR191. TR193 remains off and TR194 conducts with base bias just slightly more negative than TR193.

3.7.5 The 'B' LEVEL control in the AUTO position, or adjusted to cause the 'B' Schmitt to operate, permits

any input trigger signals of sufficient amplitude to pass fast edged square wave voltages to D193 via differentiating network C195 and R207. D193 will pass the positive-going differentiated pulses to TR193 collector and TR194 base via C198 and R216. Negative-going spikes are rejected by diode action.

The first positive-going pulse from D193 reaching TR194 base, after the negative step application to TR193 base, causes conduction changeover between TR193 and TR194, initiating the 'B' ramp. Summarising, the 'B' ramp is initiated in the VAR position of S191a by the presence of the 'A' ramp voltage and the setting of DELAY TIME MULTIPLIER R199; in the TRIG position of S191a are the foregoing conditions plus trigger pulses via D193 from the 'B' Schmitt.

3.7.6 During the period of the 'B' sweep, D198 is forward biassed and current from the unblanking amplifier then flows to the —24 V line via R222, D203, R218 and S192d. The small proportion of this current, relative to the current drawn from the same source by the 'A' ramp generator, permits a momentary brightening of the CRT trace. The adjustment of R199 positions the bright portion of the trace to any point on the 'A' trace, the length of the bright portion being dependent upon the 'B' TIME/DIV. setting.

Output voltages of both 'A' and 'B' ramp generators are converted to currents by R230 and R233 respectively, suitable for application to the 'X' amplifier. S192a, S192c and 192d or all three select either 'A', 'B' or MIXED.

CHAPTER 4

MAINTENANCE AND CALIBRATION

4.1.0 GENERAL

4.1.1 This manual should be read in conjunction with the manuals for the main frame and plug-in in use.

4.1.2 Before it is assumed a fault condition exists, control settings should be verified with reference to the pre-operational checks, para. 2.2. Where components are replaced, e.g., transistors, it is advised that the calibration checks detailed in para. 4.4.0 be carried out.

4.2.0 MECHANICAL

4.2.1 **ACCESS TO INTERIOR**

Withdraw plug-in and remove covers.

4.2.2. **LOCATION OF PRESET CONTROLS**

'A' Sweep and Trigger (PC132) are situated on the right. 'B' Sweep and Trigger (PC133) on the left.

4.3.0 CALIBRATION

4.3.1 The following procedure enables a calibration check of the plug-in to be accomplished. It is advised, that isolated adjustments are not made, due to risk of interaction with settings made in earlier checks. A functional check may be carried out as detailed in para. 4.4 below. Checking parameters are met, then proceeding to the next check. Adjustments, if made, should be minimal.

The following tools and facilities will be required:

TOOLS

Screwdrivers	Plain 4 mm. blade. Non-capacitive.
Fixture	Extension, Flexible, 067-0688-00. Rigid, 067-0689-00.
Adaptors	Screened c/w BNC Adaptors, BNC 3-way, Male/Female/Male.

Probe X10 c/w earth lead.

Oscilloscope Monitor.

Pliers flat nose.

Terminator 50 Ω

FACILITIES

Variable voltage supply (Variac).

Input Signals Sinewave		Squarewave 25 mV 1 MHz	Markers
300 mV	50 kHz		100 ms
1 V	50 kHz		1-2-5 sequence.
2 V	50 kHz		from 0·1 μs
	50 kHz		through 2 S.
	100 kHz		
	10 MHz		
0·5 mV	10 MHz		
	55 MHz		
25 mV	20 MHz		
	A.C. Line		

4.3.2 **INITIAL SETTING**

(a) Set DELAY TIME MULT to 5·0.

(b) Push REP, VAR, A ONLY, AUTO and both INTs.

(c) Depress both POLARITYs.

(d) Turn both VARIABLEs (Time) fully clockwise.

(e) Turn 'B' LEVEL fully anti-clockwise.

(f) Set both TIME/DIVs to 0·5 μs.

Note: Reference should be made to "MF" and "V" manuals for the respective initial control settings.

4.4.0 CALIBRATION PROCEDURE

4.4.1 **'A' TRIGGER**

Note 1: 'A' controls are used, unless otherwise specified.

Note: 2: Withdraw plug-in and connect to Main Frame with extension lead 195-0112-00. Remove plug-in covers.

1.0 Check Sensitivity.

1.1 Push REP, VAR, A ONLY, AC and INT.
1.2 Depress POLARITY.
1.3 Set TIME/DIV to 1 ms.
1.4a Connect 300 mV, 50 kHz sinewave to "V" input.
b Set VOLTS/DIV to give 2 div amplitude.
c Set DC-GND-AC to AC.
1.5 Connect Monitor Oscilloscope (M.O.) via screened X10 probe, to R35 (Grid 6-E3).
1.6 Set M.O., reference Plate 4.1.
1.7 Observe M.O. trace similar to Plate 4.1.
1.8 Adjust LEVEL to obtain M.O. trace.
1.9 CHECK "Y"=80 mV (0·4 div).
1.10 Adjust R36, PC132 to correct "Y" (Plate 4.1).
1.11 Release POLARITY.
1.12 CHECK.
1. Change of "Y" $<\pm 10$ mV (Plate 4.1).
2. Trace commences on negative slope.

2.0 Check Level range.

2.1 Push REP, VAR, A ONLY, AUTO and INT.
2.2 Depress POLARITY.
2.3a Connect 1 V, 50 kHz sinewave to "V" input.
b Set VOLT/DIV to 1 V.
c Set DC-GND-AC to DC.
2.4 Set TIME/DIV to 10 μs.
2.5 Rotate LEVEL to range extremities.
2.6 Observe trace may freerun at extremities only.
2.7 Adjust R26, PC132, to correct.

3.0 Check external trigger.

3.1 Repeat Ops. 2.1 and 2.2.
3.2 Connect 2 V, 50 kHz to EXT X and "V" input.
3.3 Release and depress POLARITY.
3.4 Observe start of trace coincide.
3.5 Adjust LEVEL for trace trigger point to coincide.
3.6 Push EXT.
3.7 CHECK trigger point coincides with Op. 3.4.
3.8 Adjust R7, PC132, to align trigger point, Ref. Op 3.4.
3.9 Reduce Signal Generator voltage.
3.10 Observe trace stable at 300 mV.
3.11 Push DC, AC then AC H/F REJ.
3.12 Observe trace stable at each TRIG MODE (Op. 3.12).
3.13 Push INT.
3.14 Reduce trace to 0·2 div.
3.15 Repeat Op. 3.11 and 3.12.

4.0 Check EXT. X.

4.1 Push REP, VAR, A ONLY, DC and INT.
4.2 Depress POLARITY.
4.3 Turn 'B' TIME/DIV fully anti-clockwise.
4.4 Link EXT. X to 'V' input.
4.5a Set VOLTS/DIV to 1 V.
b Connect 100 kHz sinewave to link (Op. 4.4).

4.6 Increase signal voltage till trace cross extreme verticals.
4.7 CHECK
1. Vertical difference between trace extremities $=4\pm0{\cdot}8$ Div.
2. Trace for ellipticity.
4.8 Adjust Twisted Pair, PC132, to minimize ellipticity.
4.9 Set DC-GND-AC to GND.
4.10 Adjust Signal voltage to give 5 div trace.
4.11 Increase Signal frequency to reduce trace to 3·5 divisions.
4.12 CHECK frequency $\geqq$1·4 MHz.
4.13 Push AUTO and INT.
4.14 Turn 'B' TIME/DIV clockwise.
4.15 Set DC-GND-AC to DC.
4.16 Set TIME/DIV to 0·1 μs.
4.17 Connect 55 MHz sinewave to 'V' input.
4.18 Adust LEVEL for locked trace.
4.19 CHECK amplitude $\leqq$0·5 divisions.
4.20 Repeat Ops. 3.11 and 3.12.
4.21 Connect 55 MHz sinewave to EXT.
4.22 Turn 'B' TIME/DIV to fully anti-clockwise.
4.23 Increase signal voltage for a trace.
4.24 CHECK voltage <500 mV.
4.25 Repeat Ops. 3.11 and 3.12.

5.0 Check H.F. rejection
5.1 Repeat Ops. 1.1 and 1.2.
5.2a Connect 20 MHz sinewave to 'V' input.
b Set VOLTS/DIV to give 8 div trace.
5.3 Set TIME/DIV to 0·2 μs.
5.4 Adjust LEVEL to lock trace.
5.5 Push HF/REJ.
5.6 Adjust LEVEL.
5.7 Observe (i) trace unlockable.
(ii) a single sweep at mid-range approx.

6.0 Check Line Trigger.
6.1 Repeat Ops. 2.1, 2.2 and push LINE.
6.2a Connect AC line sinewave to 'V' input.
b Set VOLTS/DIV to give 8 div trace.
6.3 Adjust LEVEL for locked trace.
6.4 Release and depress POLARITY.
6.5 Adjust LEVEL.
6.6 Observe trace locks in each POLARITY (Op. 6.4).

4.4.2 'A' SWEEP

Note: 'A' controls are used, unless otherwise specified.

1.0 Check timing.
1.1 Repeat para. 4.4.5, Ops. 2.1 and 2.2.
1.2 Turn VARIABLE fully clockwise.
1.3 Set TIME/DIV to 1 ms.
1.4a Connect 1 ms Marker Signal to 'V' input.
b Set VOLTS/DIV to give 2 div trace.
1.5 CHECK Marker/Graticule alignment.
1.6 Adjust R91, PC132 to correct alignment.

2.0 Check Pedestal voltage.
2.1 Repeat para. 4.4.5, Ops. 2.1 and 2.2.
2.2a Connect 1 ms marker signal to 'V' input.
b Set VOLTS/DIV to give 2 div trace.
2.3 Turn VARIABLE fully clockwise.
2.4 Set Monitor Oscilloscope (M.O.), reference Plate 4.2.
2.5 Connect M.O. probe to pin 33 (Grid 6-H2).
2.6 Check Y1$=15\pm0{\cdot}2$ V.
Y2$=2\pm0{\cdot}5$ V.

3.0 Check stability.
3.1 Repeat para. 4.4.5, Ops. 1.1 and 1.2.
3.2a Connect 2 V, 50 kHz to 'V' input.
b Set VOLTS/DIV to 1 V.
3.3 Set TIME/DIV to 10 μs.
3.4 Adjust LEVEL.
3.5 Observe trace locks.
3.6 Turn R73, PC132, clockwise until trace freeruns.
3.7 Note slot position.
3.8 Turn R73 anti-clockwise until trace disappears.
3.9 Note slot position.
3.10 Set R73 to centre of Ops. 3.7 and 3.9.

4.0 Check length.
4.1 Repeat para. 4.4.5, Ops. 1.1 and 1.2.
4.2 Set DC-GND-AC to GND.
4.3 Set TIME/DIV to 0·1 ms.
4.4 CHECK trace length=10·4 div.
4.5 Adjust R105, PC132, to correct length.

5.0 Check H.F. timing.
5.1 Repeat para. 4.4.5, Ops. 1.1 and 1.2.
5.2a Connect 10 MHz sinewave to 'V' input.
b Set VOLTS/DIV to give 3 div. trace.
5 3 Set TIME/DIV to 0·1 μs.
5.4 CHECK peak/graticule alignment.
5.5 Adjust C281; T/D switch (adjacent to R36, Grid 6-F2) to correct alignment.
5.6 Connect Marker Signals to 'V' input to correspond with TIME/DIV.
5.7 Repeat Ops. 5.4 and 5.6 at each TIME/DIV position.
5.8 Adjust R91, PC132, to equalize maximum errors.

6.0 Check Single Shot.
6.1 Repeat para. 4.4.5, Ops. 1.1 and 1.2.
6.2a Connect 100 ms Marker Signal to 'V' input.
b Set VOLTS/DIV to give 0·5 div trace.
c Set DC-GND-AC to AC.
6.3 Set TIME/DIV to 0·2 s.
6.4 Push SINGLE.
6.5 Observe neon extinguishes at end of sweep.
6.6 Set DC-GND-AC to GND.
6.7 Push RESET.
6.8 Observe Neon alight, no sweep.
6.9 Set DC-GND-AC to AC.
6.10 Observe Neon alight for period of sweep.

7.0 Check Hold-off time.
7.1 Set DC-GND-AC to GND.
7.2 Push AUTO.
7.3 Connect M.O. probe to pin 33 (Grid 6-H2).
7.4 Set TIME/DIV to 10 ms, 0·1 ms, 10 μs, and 0·5 μs.
7.5 Set M.O. TIME/DIV, reference Plate 4.3.
7.6 Check 'X' = 2 to 4; 1·2 to 2·4; 1·2 to 2·4; 1 to 2 div respective, reference Plate 4.3.
7.7 Adjust R108, PC132, for optimum hold-off time.

4.4.3 'B' TRIGGER

Note: 'B' controls are used, except where otherwise specified.

1.0 Check internal setting.
1.1 Set DELAY TIME MULT (DTM) to 5.
1.2 Push REP, VAR, A INT BY B, AUTO and both INTs.
1.3 Depress POLARITY.
1.4 Turn LEVEL fully anti-clockwise.
1.5 Set TIME/DIVs 'A' 10 μs, 'B' 5 μs.
1.6a Connect 1 V, 50 kHz sinewave to 'V' input.
b Set VOLTS/DIV to 1 V.
c Set DC-GND-AC to AC.
1.7 Adjust 'A' LEVEL for locked trace.
1.8 Set M.O., reference Plate 4.1.
1.9 Connect M.O. probe to junction R166/R168 (Grid 6-F5).
1.10 Observe M.O. trace is similar to Plate 4.1.
1.11 Adjust R159, PC133, to obtain M.O. trace.

Note: If R159 at end of range, change over TR151 and TR152 (Grid 6-E2).

1.12 CHECK 'Y'=60 mV (0·3 div).
1.13 Adjust R173, PC133, to correct 'Y'.
1.14 Connect M.O. probe to C195 (Grid 6-F4).
1.15 CHECK M.O. trace=1·25±0·25 V.
1.16 Reduce 'V' input to give 0·2 div trace.
1.17 Connect M.O. probe to C195 (Grid 6-F4).
1.18 CHECK M.O. trace for equal mark/space ratio.
1.19 Adjust R159 to correct mark/space ratio.
1.20 Release POLARITY.
1.21 Repeat Op. 1.18.
1.22 Push EXT.
1.23 Set M.O. TIME/DIV to 10 ms.
1.24 CHECK M.O. squarewave trace=35±15 cycles.
1.25 Set M.O. TIME/DIV to 10 μs.
1.26 Push INT.
1.27 Adjust LEVEL.
1.28 Repeat Op. 1.18.
1.29 Disconnect M.O.

4.4.4 'B' SWEEP

Note: 'B' controls are used unless otherwise specified.

1.0 Check Timing.
1.1 Repeat para. 4.4.7, Ops. 1.1 through 1.4.
1.2 Turn both VARIABLEs (speed) fully clockwise.
1.3 Set TIME/DIV 'A' 2 ms, 'B' 1 ms.
1.4a Connect 1 ms Marker Signal to 'V' input
b Set VOLTS/DIV to 2 div trace.
1.5 Set DTM to 0·5.
1.6 Push B DEL BY A.
1.7 CHECK marker/graticule alignment.
1.8 Adjust R236 to correct alignment.

2.0 Check Pedestal voltage.
2.1 Repeat para. 4.4.7, Ops. 1.1 through 1.4.
2.2a Connect 1 ms Marker Signal to 'V' input.
b Set VOLTS/DIV to give 3 div trace.
2.3 Turn VARIABLE fully clockwise.
2.4 Set M.O., reference Plate 4.2.
2.5 Connect M.O. probe to pin 16 (Grid 6-G4).
2.6 Check Y1=15·5±0·5 V.
Y2= 2·0±0·5 V.

3.0 Check H.F. timing.
3.1 Repeat para. 4.4.7, Ops. 1.1 through 1.4.
3.2a Connect 10 MHz sinewave to 'V' input.
b Set VOLTS/DIV to give 2 div trace.
3.3 Set TIME/DIVs; 'A' 0·2 μs, 'B' 0·1 μs.
3.4 Adjust DELAY TIME MULT (DTM) for first peak/graticule alignment.
3.5 CHECK peak-graticule alignment.
3.6 Adjust C255, T/D switch for optimum alignment.

4.0 Check range calibration.
4.1 Repeat para. 4.4.7, Ops. 1.1 through 1.4.
4.2 Repeat Ops. 3.2 and 3.3 above.
4.3 Turn both TIME/DIVs together anti-clockwise; 1 segment.
4.4 Set Marker Generator to correspond with 'B' TIME/DIV.
4.5 CHECK alignment.
4.6 Repeat Ops. 4.3 through 4.5.
4.7 Adjust R236, PC133, to equalize errors.

5.0 Check stability.
5.1 Repeat para. 4.4.7, Ops. 1.1 and 1.3.
5.2 Push REP, TRIG, B DEL BY A and INT.
5.3a Connect 10 MHz sinewave to 'V' input.
b Set VOLTS/DIV to give 0·5 div trace.
5.4 Set TIME/DIVs 'A' 1 μs, 'B' 0·1 μs.
5.5 Observe trace steady.
5.6 Push A INT BY B.
5.7 Turn LEVEL fully clockwise.
5.8 Set VOLTS/DIV to give 1 div trace.
5.9 Set Monitor Oscilloscope (M.O.).
Volts/Div 50 mV.
Time/Div 2 μs.
5.10 Connect M.O. probe to junction R192/R196 (Grid 6-E4).
5.11 Observe M.O. trace, reference Plate 4.4a.
5.12 Rotate LEVEL.
5.13 Observe step travels towards trailing edge, reference Plate 4.4b.
5.14 Adjust R204, PC133, reference Plate 4.4c.
a Turn clockwise for step to emerge.
b Turn anti-clockwise to just merge step with leading edge.

CAUTION. Over-adjustment is detrimental.

5.15 Disconnect M.O.
5.16 Adjust LEVEL to lock trace.
5.17 Set to AUTO.
5.18 Observe bright-up steady.
5.19 Set VOLTS/DIV to give 0·5 div trace.
5.20 Observe bright-up.
5.21 Push B DEL BY A.
5.22 Observe bright-up.

Note: Some jitter is permissible.

6.0 Check LEVEL control.
6.1 Set DTM to 5·00.
6.2 Push REP, TRIG, A INT BY B and INT.
6.3 Repeat para. 4.4.7, Ops. 1.3 and 1.4.
6.4a Connect 50 kHz sinewave to 'V' input.
b Set VOLTS/DIV to give 2 div trace.
6.5 Set TIME/DIVs; 'A' 10 μs, 'B' 5 μs.
6.6 Adjust INTENSITY for bright-up.
6.7 Rotate LEVEL.
6.8 Observe bright-up moves along slope.
6.9 Note position of bright-up.
6.10 Rotate DTM.
6.11 Observe bright-up skips to Op. 6.9 position on successive cycles.
6.12 Release and depress POLARITY.
6.13 Observe response, trace start coincide.
6.14 Set VOLTS/DIV to give 0·2 div trace.
6.15 Repeat Ops. 5.20 through 5.22 above.

7.0 Check EXT setting.
7.1a Link EXT to 'V' input.
b Set VOLTS/DIV to give 2 divs trace.
7.2 Connect 300 mV, 50 kHz sinewave to Link.
7.3 Push 'B' EXT.
7.4 Repeat Ops. 5.20 through 5.22 above.
7.5 Connect 1 MHz squarewave via terminator to EXT.
7.6 Set 'B' LEVEL to centre of range.
7.7 Remove TR155 (Grid 6-F5).
7.8 Connect M.O. probe to junction R166/R168 (Grid 6-F5).
7.9 Observe M.O. squarewave trace.
7.10 Adjust Twisted Pair, PC133, for optimum squarewave.
7.11 Fit TR155.
7.12 Remove Terminator.
7.13 Repeat Op. 7.1a.
7.14 Connect 0·5 V, 10 MHz to link.
7.15 Repeat Ops. 6.14, then 5.20 through 5.22 above.

8.0 Check Mixed.
8.1 Repeat Ops. 6.1 through 6.3 above.
8.2a Connect 50 kHz sinewave to 'V' input.
b Set VOLTS/DIV to give 2 div trace.
8.3 Set TIME/DIV; 'A' 0·5 ms, 'B' 20 μs.
8.4 Adjust INTENSITY for optimum contrast.
8.5 Turn 'B' LEVEL fully anti-clockwise.

8.6 Note position of bright-up.
8.7 Push MIXED.
8.8 Observe bright-up position as Op. 8.6.
8.9 Release 'B' POLARITY, then 'A' POLARITY.
8.10 Observe bright-up position as Op. 8.6.
8.11 Turn 'B' LEVEL clockwise.
8.12 Observe bright-up responds to Op. 8.11.
8.13 Rotate DTM through range.
8.14 CHECK DTM setting/bright-up position error <1% on horizontal scale.
8.15 Push VAR.
8.16 Rotate DTM.
8.17 Observe bright-up respond to Op. 8.16 and intensity uniform.

4.4.5 DELAY TIME MULTIPLIER

1.0 Check calibration.
1.1 Repeat para. 4.4.7, Ops. 1.1 through 1.3.
1.2 Set TIME/DIVs; 'A' 1 ms, 'B' 1 μs.
1.3 Set DC-GND-AC to GND.
1.4 Adjust INTENSITY for maximum contrast.
1.5 Adjust FINE to align 'A' trace start/1st vertical.
1.6 Set DTM to 1·0 div.
1.7 Turn DTM clockwise.
1.8 CHECK major Div/Vertical bright-up alignment error $<\pm$1% (1·0 Div).
1.9 Check Op. 1.4 alignment.
1.10 Centralize bright-up.
1.11 Set TIME/DIVs; 'A' 1 μs, 'B' 0·2 μs.
1.12 CHECK bright-up <0·45 div from centre vertical.
1.13 Set DTM to 1·0 div.
1.14 Adjust R202, PC133, to correct alignment.
1.15 Set DTM to 9·0 div.
1.16 Adjust R198, PC133, to correct alignment.
1.17 Repeat Ops. 1.13 through 1.16.
1.18 Fit plug-in covers, remove EXT lead, install plug-in into Main Frame.
1.19 Turn 'B' TIME/DIV fully anti-clockwise.
1.20 Pull FINE and centralize spot.
1.21 CHECK bright-up <0·2 div.

2.0 Check Delay Jitter.
2.1 Repeat Op. 1.18 above.
2.2 Repeat para. 4.4.7, Ops. 1.1 and 1.2.
2.3 Check polarity of Marker Signal Generator output.
2.4a Connect 0·1 ms Marker Signal to 'V' input.
b Set VOLTS/DIV to give 4 div.
c Set DC-GND-AC to DC.
2.5 Set 'A' POLARITY to match Op. 2.3.
2.6 Set TIME/DIVs; 'A' 1 ms, 'B' 1 μs.
2.7 Observe extreme right marker/bright-up alignment.
2.8 Adjust DTM to correct alignment.
2.9 Push B DEL BY A.
2.10 Adjust R90 to centralize trace.
2.11 Adjust 'B' LEVEL to minimize jitter.

Note: Lighthood may be needed.

2.12 CHECK jitter 'Y' <1 division, reference PLATE 4.5.

POSITION	R285 Loading Resistors Selected by Wafer 1F	Timing Resistors Selected by Wafer 2R	Hold Off Capacitor Selected by Wafer 1R	Timing Capacitors Selected by Wafer 2F
2 s	—	R276, R277, R278, R279, R281, R282, R283	C273 C274	C277, C278
1 s	—	R277, R278, R279, R281, R282, R283	C273 C274	C277, C278
0·5 s	—	R278, R279, R281, R282, R283	C273 C274	C277, C278
0·2 s	R271	R279, R281, R282, R283	C273, C274	C277, C278, C279
0·1 s	R271, R272	R281, R282, R283	C273, C274	C276, C277, C278, C279
50 ms	R271, R272, R273	R282, R283	C273, C274	C276, C277, C278, C279
20 ms	R271, R272, R273, R274	R283	C273, C274	C276, C277, C278, C279
10 ms	R271, R272, R273, R274, R275	—	C272, C273, C274	C276, C277, C278, C279
5 ms	—	R278, R279, R281, R282, R283	C271, C272, C273	C275, C276, C277, C279
2 ms	R271	R279, R281, R282, R283	C271, C272, C273	C275, C276, C277, C279
1 ms	R271, R272	R281, R282, R283	C271, C272, C273	C275, C276, C277, C279
·5 ms	R271, R272, R273	R282, R283	C271, C272, C273	C275, C276, C277, C279
·2 ms	R271, R272, R273, R274	R283	C271, C272, C273	C275, C276, C277, C279
·1 ms	R271, R272, R273, R274, R275	—	C271, C272, C273	C275, C276, C277, C279
50 µs	R271, R272, R273	R282, R283	C272, C273	C276, C277, C279
20 µs	R271, R272, R273, R274	R283	C272, C273	C276, C277, C279
10 µs	R271, R272, R273, R274, R275	—	C272, C273	C276, C277, C279
5 µs	R271, R272, R273	R282, R283	C273	C276, C279
2 µs	R271, R272, R273, R274	R283	C273	C276, C279
1 µs	R271, R272, R273, R274, R275	—	C273	C276, C279
·5 µs	—	—	C273	C276, C279
·2 µs	—	—	—	C276
·1 µs	—	—	—	—

'A' TIME/DIV S271

POSITION	Timing resistors selected by wafer 2R	Timing Capacitors selected by wafer 2F
1 S	R251 - R257	C254, C251, C255, C252
·5 S	R252 - R257	C254, C251, C255, C252
·2 S	R253 - R257	C254, C251, C255, C252, C256
·1 S	R254 - R257	C254, C251, C255, C252, C256, C253
50 mS	R255 - R256	C254, C251, C255, C252, C256, C253
20 mS	R256 - R257	C254, C251, C255, C252, C256, C253
10 mS	R257	C254, C251, C255, C252, C256, C253
5 mS	R252 - R257	C257, C251, C255, C252, C256, C253
2 mS	R253 - R257	C257, C251, C255, C252, C256, C253
1 mS	R254 - R257	C257, C251, C255, C252, C256, C253
·5 mS	R255 - R257	C257, C251, C255, C252, C256, C253
·2 mS	R256 - R257	C257, C251, C255, C252, C256, C253
·1 mS	R257	C257, C251, C255, C252, C256, C253
50 µS	R255 - R257	C251, C255, C252, C256, C253
20 µS	R256 - R257	C251, C255, C252, C256, C253
10 µS	R257	C255, C252, C256, C253
5 µS	R255 - R257	C255, C252, C256, C253
2 µS	R256 - R257	C255, C252, C256, C253
1 µS	R257	C256, C253
·5 µS	R257 - R258	C256, C253
·2 µS	R257 - R258	C253
·1 µS	R257 - R258	—

'B' TIME/DIV S251

TABLE — SWITCH CONNEXIONS

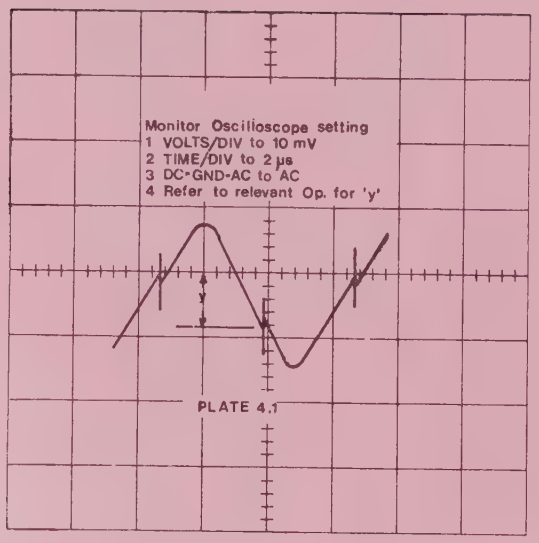

PLATE 4.1

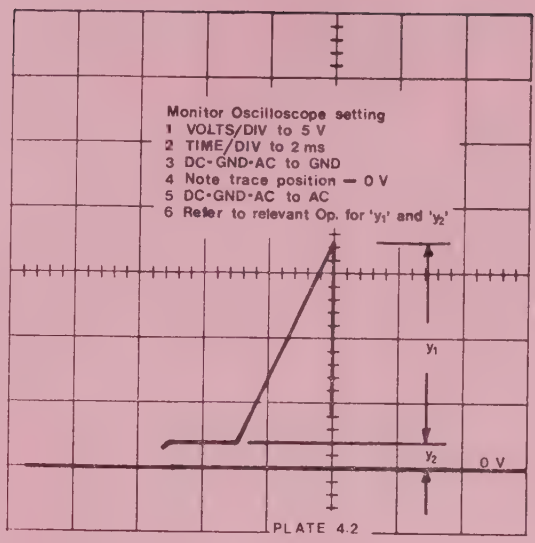
Monitor Oscilloscope setting
1 VOLTS/DIV to 5 V
2 TIME/DIV to 2 ms
3 DC-GND-AC to GND
4 Note trace position — 0 V
5 DC-GND-AC to AC
6 Refer to relevant Op. for 'y1' and 'y2'
y1
y2
0 V

PLATE 4.2

Monitor Oscilloscope for Checking	set TIME/DIV
10 ms/div	2 ms
0.1 ms/div	50 µs
10 µs/div	5 µs
0.5 µs/div	1 µs

Refer to relevant Op. for 'x'

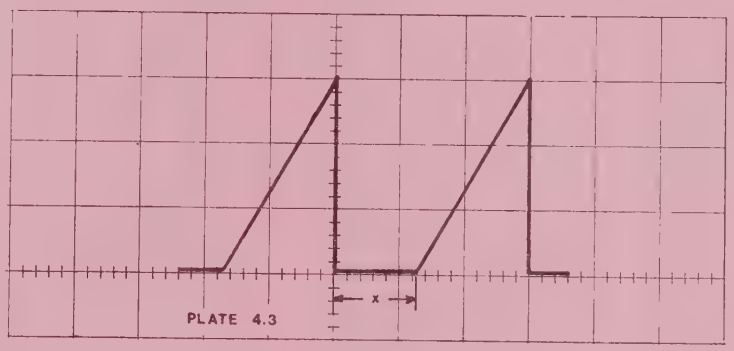

PLATE 4.3

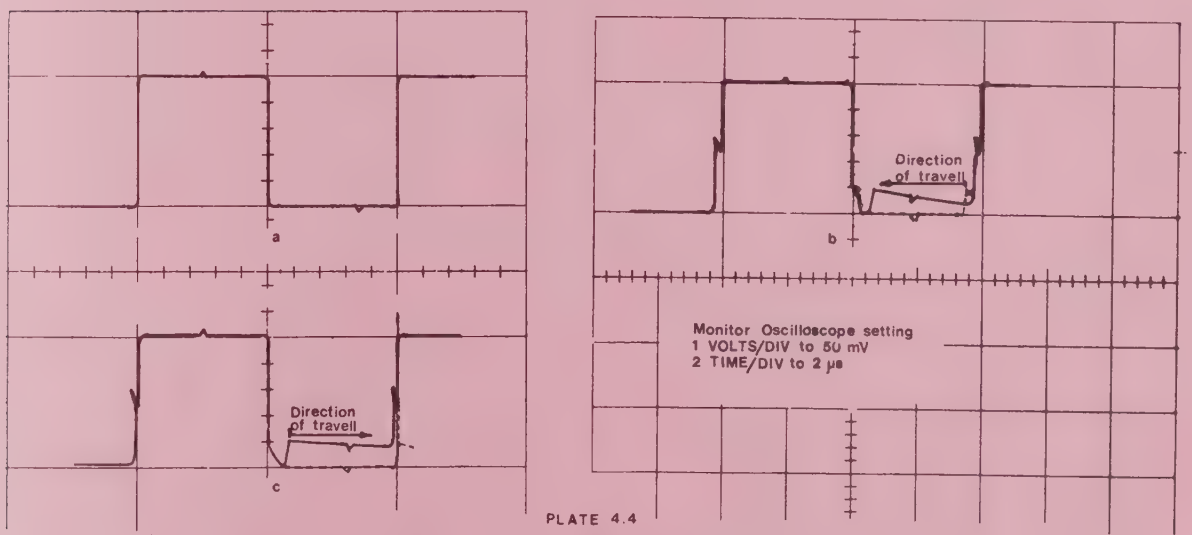

PLATE 4.4

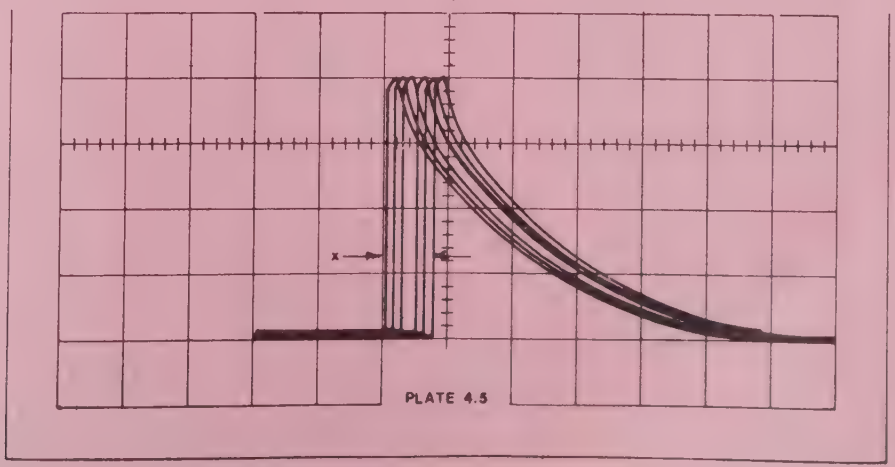

PLATE 4.5

CHAPTER 5
COMPONENT LIST

Values of resistors are stated in ohms or multiples of ohms; ratings at 70°C are in watts or sub-multiples of watts. Values of capacitors are stated in sub-multiples of farads; ratings at 70°C are in volts or kilovolts.

Whenever possible, exact replacements for components should be used, although locally available alternative may be satisfactory for standard components.

Any order for replacement parts should include:

1. Instrument type
2. Instrument serial number
3. Component circuit reference
4. Component part number
5. Component Value

CIRCUIT REFERENCE BLOCKS

The table below gives the blocks of circuit references, so that the reader can relate the items listed in this chapter and their location in the circuitry and printed circuit boards in Chapter 6.

Circuit Reference		Circuit	Fig.	P.C. Board No.
From	To			
1	60	'A' Trigger Amplifier	1	132
61	150	Generator	2	132
151	190	'B' Trigger Amplifier	4	133
191	250	Generator	5	133
251	300	Time/Div Switch	3	136

ABBREVIATIONS

BM	Button mica	CMP	Cermet preset	PS	Polystyrene
C	Carbon	E	Electrolytic	Se	Selenium
CP	Carbon preset	Ge	Germanium	Si	Silicon
CV	Carbon variable	MF	Metal film	SM	Silver mica
CER	Ceramic	MO	Metal oxide	WW	Wire-wound
CT	Ceramic trimmer	PE	Polyester	WWP	Wire-wound preset
CM	Cermet thick film	PP	Polypropylene	WWV	Wire-wound variable

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All requests for repairs or replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service.

Cir Ref	Part Number	Description Value F	Type	Tol %	Rating V
C1	285-0946-00	470 n	PE	20	250
C2	285-0796-00	100 n	PE	20	250
C3	290-0623-00	4·7 μ	E		40
C4	290-0623-00	4·7 μ	E		40
C5	290-0623-00	4·7 μ	E		40
C6	285-0915-00	100 n	PE	20	100
C7	285-0915-00	100 n	PE	20	100
C9	281-0710-00	10 n	CER		250
C11	285-0847-00	560 p	PS	5	125
C12	281-0710-00	10 n	CER		250
C13	285-0920-00	56 p	PS	2 p	350
C14	290-0627-00	22 μ	E		40
C15	285-0842-00	15 p	PS	1 p	350
C61	285-0871-00	150 p	PS	5	350
C62	290-0627-00	22μ	E		40
C63	285-0779-00	470 n	PE	20	100
C64	281-0710-00	10 n	CER		250
C65	285-0940-00	12 p	PS	1 p	350
C66	285-0845-00	68 p	PS	2 p	350
C67	285-0854-00	100 p	PS	2 p	350
C68	281-0710-00	10 n	CER		250
C71	285-0776-00	27 p	PS	1 p	350
C72	285-0836-00	47 n	PE	20	250
C74	281-0711-00	3·9 p	CER	0·25 p	750
C75	285-0940-00	12 p	PS	1 p	350
C76	285-0866-00	10 p	PS	1 p	350
C77	281-0710-00	10 n	CER		250
C78	285-0867-00	20 p	PS	1 p	350
C79	285-0869-00	47 p	PS	2 p	350
C81	285-0873-00	200 p	PS	5	350
C150	281-0712-00	5 p	CER	0·25 p	750
C151	285-0946-00	470 n	PE	20	250
C152	290-0627-00	22 μ	E		40
C153	285-0866-00	10 p	PS	1 p	350
C154	290-0627-00	22 μ	E		40
C155	285-0915-00	100 n	PE	20	100
C156	285-0776-00	27 p	PS	1 p	350
C157	290-0623-00	4·7 μ	E		40
C158	285-0786-00	33 p	PS	2 p	350
C159	285-0854-00	100 p	PS	2 p	350

Cir Ref	Part Number	Description Value F	Type	Tol %	Rating V
C192	281-0745-00	4·7 p	CER	0·5 p	500
C194	285-0867-00	20 p	PS	1 p	350
C195	285-0838-00	75 p	PS	2 p	350
C196	285-0873-00	200 p	PS	5	350
C197	290-0648-00	150 μ	E		25
C198	285-0870-00	120 p	PS	2	350
C199	285-0915-00	100 n	PE	20	100
C201	281-0711-00	3·9 p	CER	0·25 p	750
C202	290-0634-00	22 μ	E		160
C203	285-1014-00	1 μ	PE	20	63
C204	285-0838-00	75 p	PS	2 p	350
C205	285-0867-00	20 p	PS	1 p	350
C206	281-0710-00	10 n	CER		250
C251	283-0721-00	900 p	SM	1	350
C252	283-0723-00	10 p	SM	0·5 p	350
C253	281-0738-00	20 p	CER	0·25 p	750
C254	285-0943-00	1 μ	PC	1	63
C255	281-0732-00	3-12 p	CT		250
C256	283-0722-00	60 p	SM	1 p	350
C257	285-1023-00	9 n	PC	1	400
C271	285-0792-00	4·7 n	PE	20	125
C272	285-0874-00	470 p	PS	5	125
C273	285-0786-00	33 p	PS	2 p	350
C274	285-0791-00	470 n	PE	10	125
C275	285-1023-00	9 n	PC	1	400
C276	281-0738-00	20 p	CER	0·25 p	750
C277	283-0721-00	900 p	SM	1	350
C278	285-0943-00	1 μ	PC	1	63
C279	283-0722-00	60 p	SM	1	350
C281	281-0732-00	3-12 p	CT		250
C282	283-0723-00	10 p	SM	0·5 p	350

Clr Ref	Part Number	Value V	Description	Type	Tol %	Rating
D1	152-0062-01		1N914/1N4148	Si		75 V
D2	152-0062-01		1N914/1N4148	Si		75 V
D3	152-0472-00	5·6	Zener	Si	5	330 mW
D4	152-0062-01		1N914/1N4148	Si		75 V
D5	152-0062-01		1N914/1N4148	Si		75 V
D6	152-0062-01		1N914/1N4148	Si		75 V
D7	152-0348-00	6·2	Zener	Si	5	330 mW
D8	152-0472-00	5·6	Zener	Si	5	330 mW
D61	152-0062-01		1N914/1N4148	Si		75 V
D62	152-0062-01		1N914/1N4148	Si		75 V
D63	152-0062-01		1N914/1N4148	Si		75 V
D64	152-0062-01		1N914/1N4148	Si		75 V
D65	152-0062-01		1N914/1N4148	Si		75 V
D66	152-0062-01		1N914/1N4148	Si		75 V
D67	152-0062-01		1N914/1N4148	Si		75 V
D68	152-0062-01		1N914/1N4148	Si		75 V
D69	152-0541-00		BAY 82	Si		10 V
D71	152-0483-00		25 pA leakage current at −6 V and 25°C	Si		
D72	152-0062-01		1N914/1N4148	Si		75 V
D73	152-0062-01		1N914/1N4148	Si		75 V
D74	152-0062-01		1N914/1N4148	Si		75 V
D75	152-0062-01		1N914/1N4148	Si		75 V
D76	152-0062-01		1N914/1N4148	Si		75 V
D193	152-0062-01		1N914/1N4148	Si		75 V
D194	152-0062-01		1N914/1N4148	Si		75 V
D195	152-0062-01		1N914/1N4148	Si		75 V
D196	152-0541-00		BAY 82	Si		10 V
D197	152-0483-00		25 pA leakage current at −6 V and 25°C	Si		
D198	152-0062-01		1N914/1N4148	Si		75 V
D199	152-0062-01		1N914/1N4148	Si		75 V
D201	152-0466-00	15	Zener	Si	5	330 mW
D202	152-0062-01		1N914/1N4148	Si		75 V
D203	152-0062-01		1N914/1N4148	Si		75 V

Clr Ref	Part Number	Value	Description
L1	108-0720-00	7·7 μH	Fixed Inductor
L2	108-0483-00	16 μH	Fixed Inductor
L61	108-0481-00	1·3 μH	Fixed Inductor

Cir Ref	Part Number	Value ohms	Description Type	Tol %	Rating W
R1	317-0104-01	100 k	C	5	125 m
R2	317-0103-01	10 k	C	5	125 m
R3	317-0183-01	18 k	C	5	125 m
R4	317-0513-01	51 k	C	5	125 m
R5	315-0433-02	43 k	C	5	250 m
R6	317-0432-01	4·3 k	C	5	125 m
R7	311-0995-00	680	CP	20	250 m
R8	317-0201-01	200	C	5	125 m
R9	317-0562-01	5·6 k	C	5	125 m
R10	317-0102-01	1 k	C	5	125 m
R11	317-0151-01	150	C	5	125 m
R12	317-0621-01	620	C	5	125 m
R13	317-0750-01	75	C	5	125 m
R14	317-0153-01	15 k	C	5	125 m
R15	317-0123-01	12 k	C	5	125 m
R16	317-0100-01	10	C	5	125 m
R17	317-0392-01	3·9 k	C	5	125 m
R18	317-0822-01	8·2 k	C	5	125 m
R19	317-0752-01	7·5 k	C	5	125 m
R21	317-0562-01	5·6 k	C	5	125 m
1009 R22	311-1575-00	7·5 k	CV	10	1 w
R23	317-0101-01	100	C	5	125 m
R24	317-0822-01	8·2 k	C	5	125 m
R25	317-0104-01	100 k	C	5	125 m
R26	311-0802-00	4·7 k	CP	20	250 m
R27	317-0123-01	12 k	C	5	125 m
R28	317-0100-01	10	C	5	125 m
R29	317-0222-01	2·2 k	C	5	125 m
R31	317-0750-01	75	C	5	125 m
R32	317-0511-01	510	C	5	125 m
R33	317-0122-01	1·2 k	C	5	125 m
R34	317-0153-01	15 k	C	5	125 m
R35	317-0100-01	10	C	5	125 m
R36	311-1388-00	47	CP	20	250 m
R38	317-0220-01	22	C	5	125 m
R39	317-0182-01	1·8 k	C	5	125 m
R41	317-0101-01	100	C	5	125 m
R42	317-0100-01	10	C	5	125 m
R43	317-0223-01	22 k	C	5	125 m
R62	317-0153-01	15 k	C	5	125 m
R63	317-0105-01	1 M	C	5	125 m
R64	317-0682-01	6·8 k	C	5	125 m
R65	317-0393-01	39 k	C	5	125 m
R66	317-0203-01	20 k	C	5	125 m
R67	317-0473-01	47 k	C	5	125 m
R68	317-0101-01	100	C	5	125 m
R69	317-0392-01	3·9 k	C	5	125 m
R71	317-0622-01	6·2 k	C	5	125 m
R72	317-0153-01	15 k	C	5	125 m
R73	311-0735-00	10 k	CP	20	250 m
R74	317-0682-01	6·8 k	C	5	125 m
R75	317-0331-01	330	C	5	125 m
R76	317-0332-01	3·3 k	C	5	125 m
R77	317-0472-01	4·7 k	C	5	125 m

Cir Ref	Part Number	Value ohms	Description Type	Tol %	Rating W
R78	321-0291-48	10·5 k	MF	1	125 m
R79	317-0470-01	47	C	5	125 m
R80	317-0471-01	470	C	5	125 m
R81	317-0183-01	18 k	C	5	125 m
R82	317-0392-01	3·9 k	C	5	125 m
R83	317-0473-01	47 k	C	5	125 m
R84	317-0472-01	4·7 k	C	5	125 m
R85	321-0373-48	75 k	MF	1	125 m
R86	317-0823-01	82 k	C	5	125 m
R87	321-0293-48	11 k	MF	1	125 m
R88	317-0562-01	5·6 k	C	5	125 m
R89	321-0291-48	10·5 k	MF	1	125 m
R90	311-0913-00	1·5 k	CP	20	250 m
R91	311-0798-00	2·2 k	CP	20	250 m
R92	317-0124-01	120 k	C	5	125 m
R93	317-0104-01	100 k	C	5	125 m
R94	317-0221-01	220	C	5	125 m
R95	317-0201-01	200	C	5	125 m
R96	317-0221-01	220	C	5	125 m
R97	317-0562-01	5·6 k	C	5	125 m
R98	317-0154-01	150 k	C	5	125 m
R99	317-0203-01	20 k	C	5	125 m
R101	316-0475-01	4·7 M	C	10	250 m
R102	317-0225-01	2·2 M	C	5	125 m
R103	317-0433-01	43 k	C	5	125 m
R104	317-0473-01	47 k	C	5	125 m
R105	311-0750-00	22 k	CP	20	250 m
R106	317-0393-01	39 k	C	5	125 m
R107	317-0122-01	1·2 k	C	5	125 m
R108	311-0851-00	1 k	CP	20	250 m
R109	317-0222-01	2·2 k	C	5	125 m
R111	317-0243-01	24 k	C	5	125 m
R112	317-0512-01	5·1 k	C	5	125 m
R113	317-0105-01	1 M	C	5	125 m
R114	317-0433-01	43 k	C	5	125 m
R115	317-0513-01	51 k	C	5	125 m
R116	317-0104-01	100 k	C	5	125 m
R117	317-0753-01	75 k	C	5	125 m
R118	317-0302-01	3 k	C	5	125 m
R151	317-0104-01	100 k	C	5	125 m
R152	317-0682-01	6·8 k	C	5	125 m
*R153	311-1353-00	47 k	CV	20	250 m
R154	317-0184-01	180 k	C	5	125 m
R155	317-0163-01	16 k	C	5	125 m
R156	321-1308-48	16 k	MF	1	125 m
R157	317-0133-01	13 k	C	5	125 m
R158	317-0241-01	240	C	5	125 m
R159	311-0798-00	2·2 k	CP	20	250 m
R161	315-0513-02	51 k	C	5	250 m
R162	317-0133-01	13 k	C	5	125 m
R163	321-1308-48	16 k	MF	1	125 m
R164	317-0163-01	16 k	C	5	125 m
R165	317-0822-01	8·2 k	C	5	125 m
R166	317-0362-01	3·6 k	C	5	125 m
R167	317-0514-01	510 k	C	5	125 m

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*With S153

Cir Ref	Part Number	Value ohms	Description Type	Tol %	Rating W
R168	317-0123-01	12 k	C	5	125 m
R169	317-0101-01	100	C	5	125 m
R171	317-0392-01	3·9 k	C	5	125 m
R172	317-0222-01	2·2 k	C	5	125 m
R173	311-1388-00	47	CP	20	250 m
R174	317-0822-01	8·2 k	C	5	125 m
R175	317-0121-01	120	C	5	125 m
R176	317-0392-01	3·9 k	C	5	125 m
R177	317-0153-01	15 k	C	5	125 m
R191	321-1353-48	47 k	MF	1	125 m
R192	317-0392-01	3·9 k	C	5	125 m
R193	321-1353-48	47 k	MF	1	125 m
R194	317-0224-01	220 k	C	5	125 m
R195	317-0182-01	1·8 k	C	5	125 m
R196	317-0273-01	27 k	C	5	125 m
R197	321-0276-48	7·32 k	MF	1	125 m
R198	311-1420-00	3·3 k	WWP	10	1
R199	311-1387-00	5 k	WWV	5	750 m
R200	317-0221-01	220	C	5	125 m
R201	321-0178-48	698	MF	1	125 m
R202	311-1381-00	680	WWP	10	1
R203	317-0392-01	3·9 k	C	5	125 m
R204	311-0735-00	10 k	CP	20	250 m
R205	317-0223-01	22 k	C	5	125 m
R206	317-0272-01	2·7 k	C	5	125 m
R207	317-0102-01	1 k	C	5	125 m
R208	317-0271-01	270	C	5	125 m
R209	321-1296-48	12 k	MF	1	125 m
R211	317-0472-01	4·7 k	C	5	125 m
R212	317-0103-01	10 k	C	5	125 m
R213	321-0298-48	12·4 k	MF	1	125 m
R214	321-0402-48	150 k	MF	1	125 m
R215	317-0104-01	100 k	C	5	125 m
R216	317-0912-01	9·1 k	C	5	125 m
R217	317-0681-01	680	C	5	125 m
R218	317-0393-01	39 k	C	5	125 m
R219	317-0473-01	47 k	C	5	125 m
R221	317-0472-01	4·7 k	C	5	125 m
R222	321-0294-48	11·3 k	MF	1	125 m
R223	317-0123-01	12 k	C	5	125 m
R224	317-0101-01	100	C	5	125 m
R225	317-0101-01	100	C	5	125 m
R227	317-0154-01	150 k	C	5	125 m
R228	317-0221-01	220	C	5	125 m
R229	317-0203-01	20 k	C	5	125 m
R230	321-0306-48	15 k	MF	1	125 m

Cir Ref	Part Number	Value ohms	Description Type	Tol %	Rating W
R231	315-0102-02	1 k	C	5	250 m
R232	317-0133-01	13 k	C	5	125 m
R233	321-0306-48	15 k	MF	1	125 m
R234	317-0332-01	3·3 k	C	5	125 m
R235	317-0362-01	3·6 k	C	5	125 m
R236	311-0719-00	470	CP	20	250 m
R237	317-0103-01	10 k	C	5	125 m
R238	317-0204-01	200 k	C	5	125 m
R239	317-0204-01	200 k	C	5	125 m
R251	324-0616-40	7·5 M	MF	1	1
R252	324-0544-40	4·53 M	MF	1	1
R253	322-0498-40	1·5 M	MF	1	250 m
R254	321-0469-48	750 k	MF	1	125 m
R255	321-0448-48	453 k	MF	1	125 m
R256	321-0402-48	150 k	MF	1	125 m
R257	321-0402-48	150 k	MF	1	125 m
R258	321-0402-48	150 k	MF	1	125 m
R259	317-0103-01	10 k	C	5	125 m
R261	311-1356-00	22 k	CV	20	250 m
R271	317-0302-01	3 k	C	5	125 m
R272	317-0332-01	3·3 k	C	5	125 m
R273	317-0562-01	5·6 k	C	5	125 m
R274	317-0183-01	18 k	C	5	125 m
R275	321-0355-48	48·7 k	MF	1	125 m
R276	324-0594-40	15 M	MF	1	1
R277	324-0616-40	7·5 M	MF	1	1
R278	324-0544-40	4·53 M	MF	1	1
R279	322-0498-40	1·5 M	MF	1	250 m
R281	321-0469-48	750 k	MF	1	125 m
R282	321-0448-48	453 k	MF	1	125 m
R283	321-0402-48	150 k	MF	1	125 m
R284	317-0154-01	150 k	C	5	125 m
R285	311-1355-00	100 k	CV	20	250 m
R286	317-0223-01	22 k	C	5	125 m
R287	321-0402-48	150 k	MF	1	125 m
R288	317-0103-01	10 k	C	5	125 m
R289	321-0402-48	150 k	MF	1	125 m

Cir Ref	Part Number	Description
S1	260-1403-00	Push (3-button)
S2	260-1401-00	Push (1-button)
S3	260-1402-00	Push (4-button)

Cir Ref	Part Number	Description
S61, S62	260-1405-00	Push (3-button)

Cir Ref	Part Number	Description
S151	260-1401-00	Push (1-button)
S152	260-1400-00	Push (2-button)
S153	311-1353-00	Rotary (with R153)

Cir Ref	Part Number	Description
S191, S192	260-1499-00	Push (5-button)
S251	260-1411-00	Rotary (23-position)
S271	260-1410-00	Rotary (23-position)

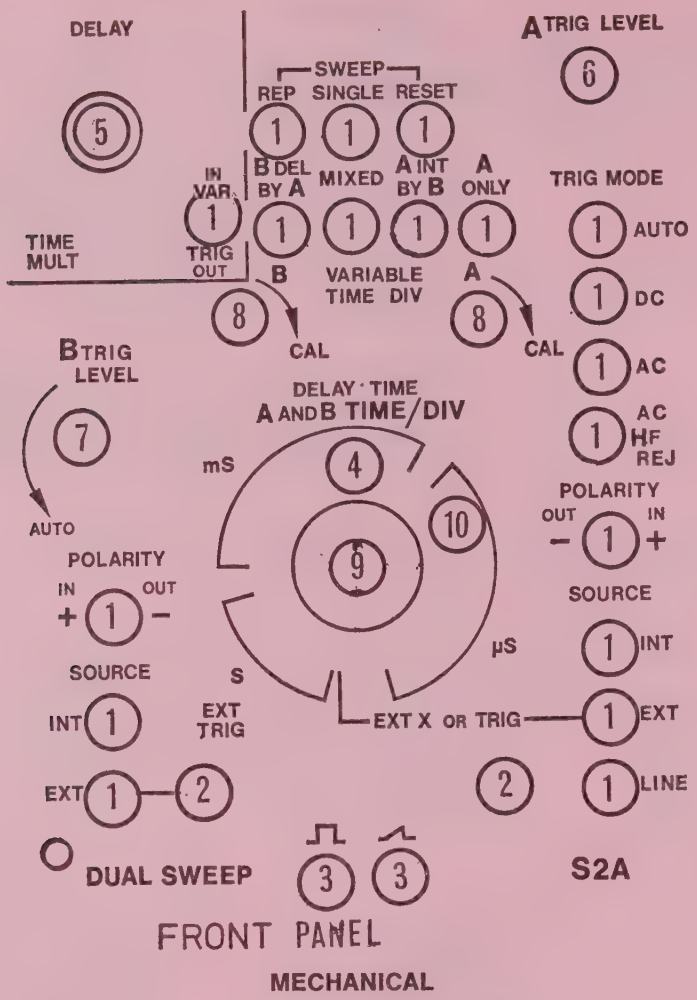
Cir Ref	Part Number	Value	Description	Tol.	Rating
TH1	307-0270-00	330 Ω	Thermistor	20%	500 mW

Cir Ref	Part Number	Description		
TR1	151-0127-02	BSX20	Si	NPN
TR2	151-0320-00	MPS6518/BFX48	Si	PNP
TR3	151-0127-02	BSX20/2N2369	Si	NPN
TR4	151-0127-02	BSX20/2N2369	Si	NPN
TR5	151-0320-00	MPS6518/BFX48	Si	PNP
TR6	151-0127-02	BSX20/2N2369	Si	NPN
TR7	151-0127-02	BSX20/2N2369	Si	NPN
TR61	151-0320-00	MPS6518/BFX48	Si	PNP
TR62	151-0320-00	MPS6518/BFX48	Si	PNP
TR63	151-0127-02	BSX20/2N2369	Si	NPN
TR64	151-0127-02	BSX20/2N2369	Si	NPN
TR65	151-0320-00	MPS6518/BFX48	Si	PNP
TR66	151-1062-00	FET Telequipment spec.	Si	N-Channel
TR67	151-0242-00	2N3904	Si	NPN
TR68	151-0317-00	BC109C	Si	NPN
TR69	151-0242-00	2N3904	Si	NPN
TR151	151-0127-02	BSX20/2N2369	Si	NPN
TR152	151-0127-02	BSX20/2N2369	Si	NPN
TR153	151-0320-00	MPS6518/BFX48	Si	PNP
TR154	151-0127-02	BSX20/2N2369	Si	NPN
TR155	151-0127-02	BSX20/2N2369	Si	NPN
TR191	151-0320-00	MPS6518/BFX48	Si	PNP
TR192	151-0320-00	MPS6518/BFX48	Si	PNP
TR193	151-0320-00	MPS6518/BFX48	Si	PNP
TR194	151-0320-00	MPS6518/BFX48	Si	PNP
TR195	151-0320-00	MPS6518/BFX48	Si	PNP
TR196	151-1062-00	FET Telequipment spec.	Si	N-Channel
TR197	151-0242-00	2N3904	Si	NPN

V61	150-0105-00	Neon capless 34L

ASSEMBLIES

Assembly	Part Number	Includes Circuit References
'A' Sweep & Trigger PC132	670-2186-00	C1 to C4, C6 to C9, C11 to C15, C61 to C68, C71, C72, C74 to C79, C81, D1, D2, D4 to D7, D61 to D69, D71 to D74, D76, L1, L61, R1 to R6, R8 to R11, R13 to R19, R21, R23 to R29, R31 to R36, R38, R39, R41 to R43, R62 to R69, R71 to R79, R81 to R89, R92 to R99, R101 to R109, R111 to R118, S1 to S3, TR1 to TR7, TR61 to TR69
'A' TIME/DIV switch	262-0958-00	C271 to C279, C281, C282, R287, R289
'B' Sweep & Trigger PC133	670-2187-00	C5, C151 to C159, C192 to C199, C201, C202, C204, D3, D193 to D195, D197 to D199, D201 to D203, R12, R151, R152, R154 to R159, R161 to R169, R171, R172, R174, R176, R177, R191 to R197, R201 to R209, R211 to R216, R219, R221 to R225, R231 to R237, S151, S152, TR151 to TR155, TR191 to TR197
'B' TIME/DIV switch	262-0959-00	C251 to C257, R251 to R258
Reset Lamp PC140	670-2354-00	V61
Timing Resistor PC136	670-2190-00	R271 to R279, R281 to R283



MECHANICAL

	Part Number	Description	Location
	136-0343-00	Base Transistor, T018	PCB
	136-0344-00	Base Transistor, 4 pin	PCB
	366-1403-00	Button, Push	1
	343-0191-00	Clamp, Cable	
	131-0650-01	Connector, Bulkhead Socket BNC	2
	131-1268-00	Connector, Single Pole 2 mm	3
	131-0649-00	Connector, Male BNC	Accessory
	331-0316-00	Dial, Time/Div	4
	331-0317-00	Dial, Turns Counting	5
	210-0735-00	Eyelet, L.613	PCB
	210-0739-00	Eyelet, L.737	PCB
	003-0674-00	Key, Allen 1·5 mm A/F	6 - 10
	003-0703-00	Key, Nut Locking	5
	003-0706-00	Key, Special Allen	5
1095	366-1238-00	Knob, Grey/Black	6
	366-1239-00	Knob, Grey/Black	7
	366-1266-00	Knob, Grey/Black	8
	366-1289-00	Knob, Grey/Red	9
	366-1386-00	Knob, Transparent	10
	220-0527-00	Nut, Chrome	6 - 10
	004-1143-00	Packaging	Accessory
	213-0248-00	Screw, Socket, 3 x 3 mm	6 - 10
	385-0206-00	Spacer, 6 BA/8 BA x ·5"	1
	361-0478-00	Spacer, Special	4
	105-0347-00	Stop	Rear of Mod.
	343-0198-00	Strap, Cable Insuloid	
	210-0275-00	Tag, Solder, ⅜"	
1009	210-1177-00	Washer	6

CHAPTER 6

CIRCUIT DIAGRAMS

To minimize the risk of misinterpretation of component values on circuit diagrams, the decimal point has been replaced by the multiplier or sub-multiplier of the basic unit. For instance, 2·2 megohms is shown as 2M2 and 1·8 picofarads is shown as 1p8.

To aid the reader further, in addition to the block Circuit Reference Table in Chapter 5.1, to locate a component in the circuit diagrams, a table is provided at the top of each circuit diagram, in which the circuit reference will appear, where practicable, directly above the component being sought.

PRINTED CIRCUIT

Blue shows the rear track as seen through the board. Yellow the component side track.

Location of components are listed on the page preceding the PCBs.

WAVEFORMS

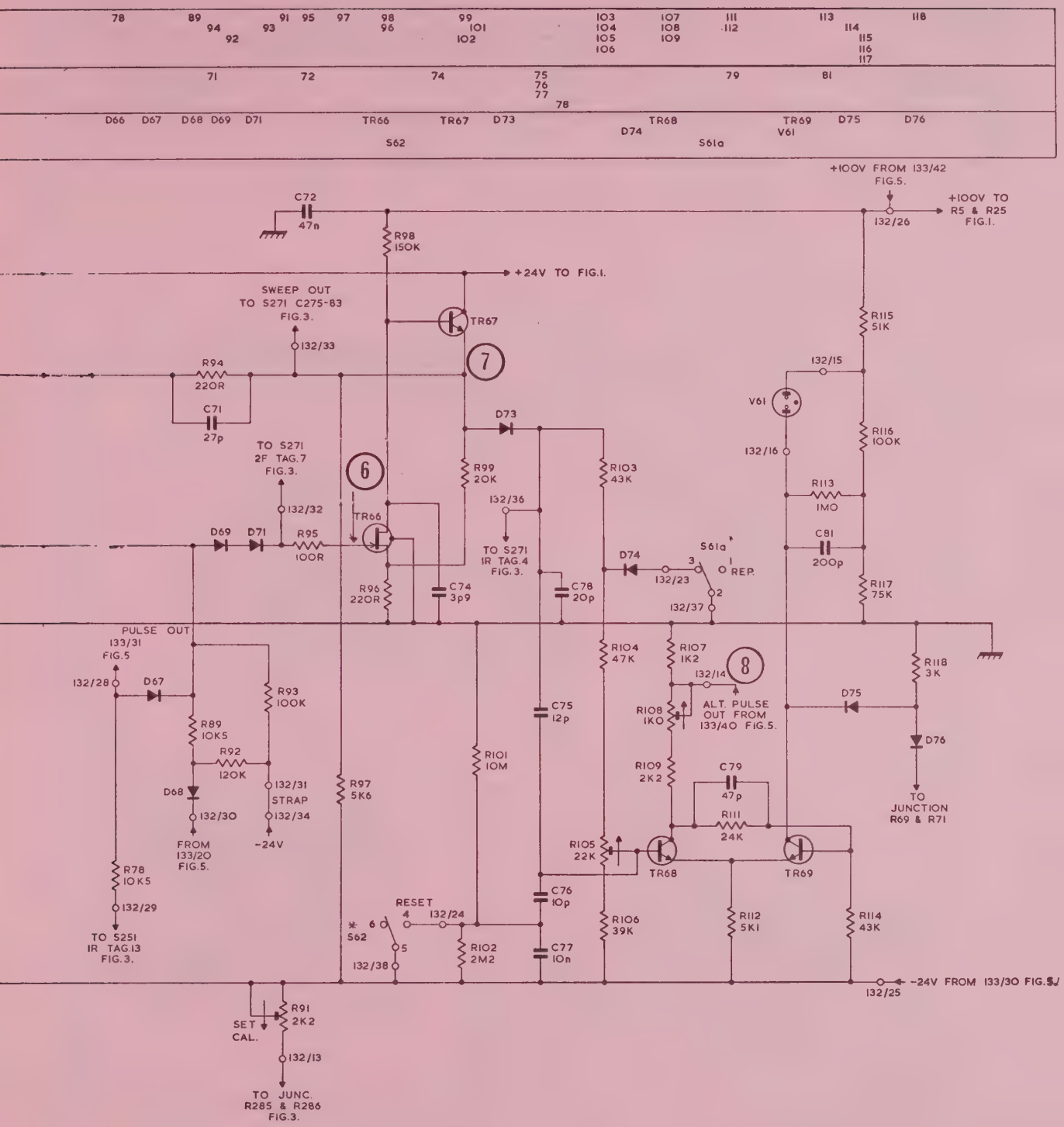
Waveforms, illustrated in Plates 6/1 and 6/2, may be monitored at point with the corresponding number.

PLATE 6/1

DUAL SWEEP TYPE S2A
A TRIGGER AMPLIFIER
FIG.1

NOTES.
1. * DENOTES COMPONENTS NOT MOUNTED ON P.C. BOARD.
2. 132/0 DENOTES P.C. BOARD/EYELET OR TERMINAL No.

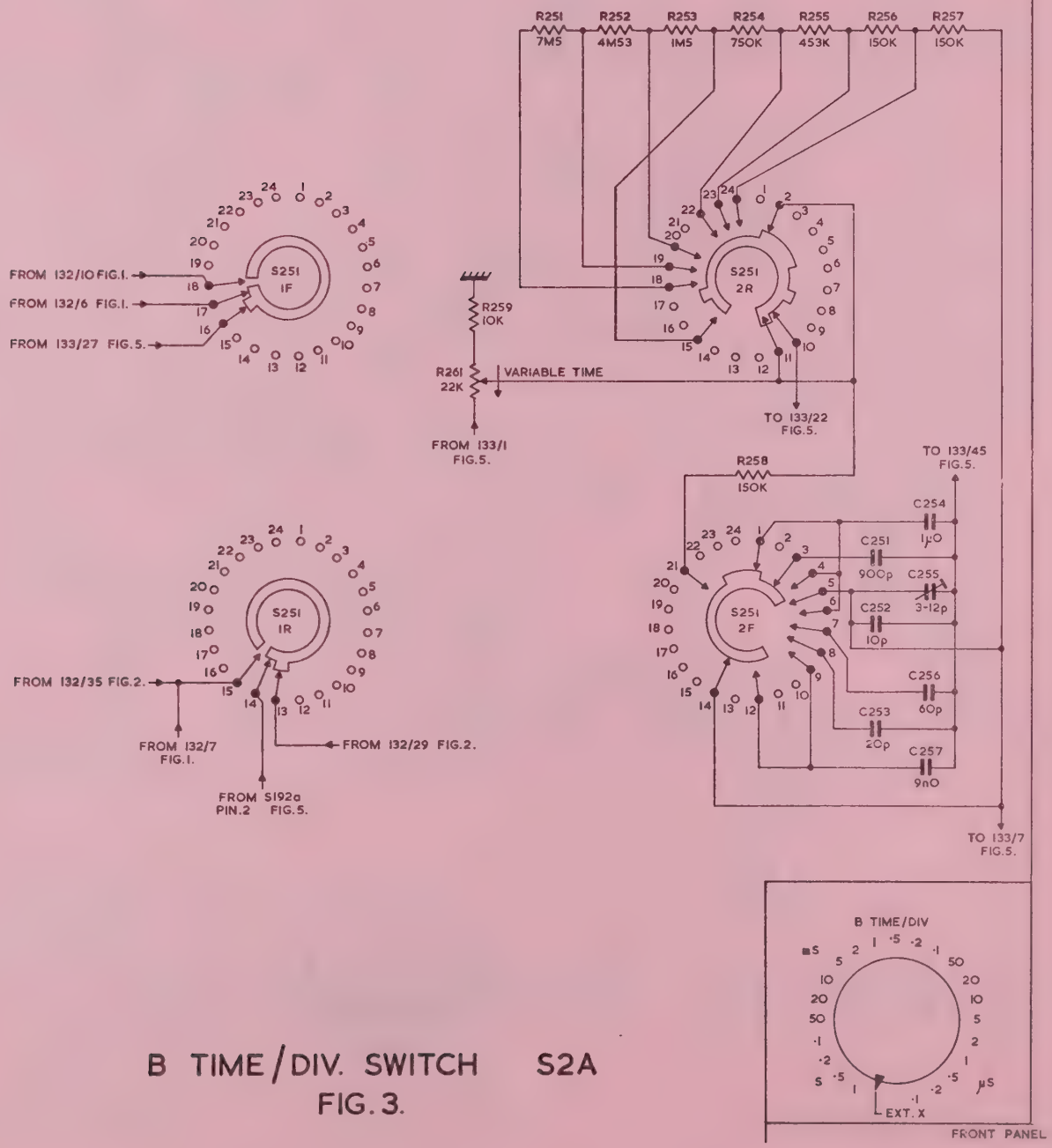
| | | |



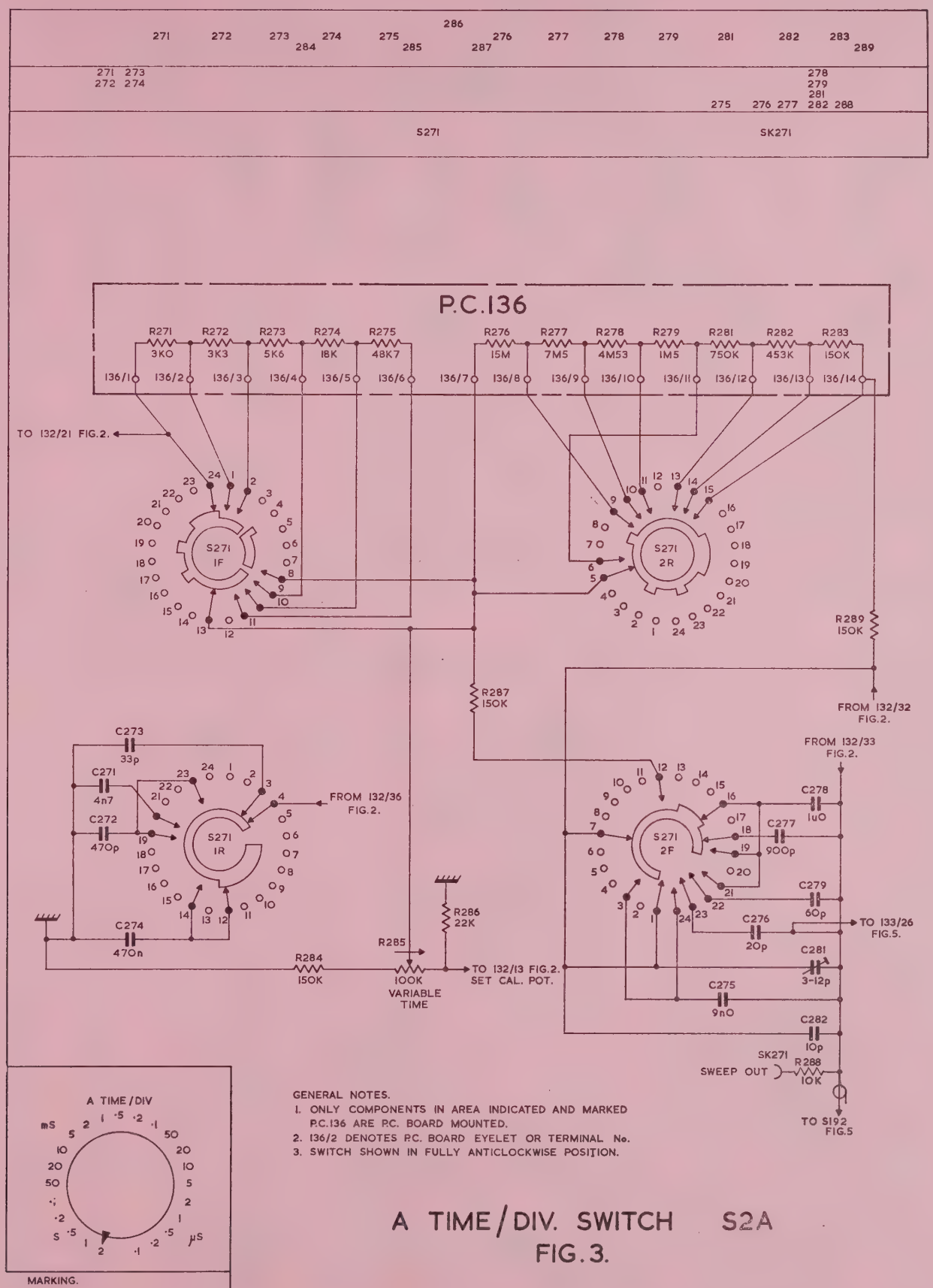
ON P.C. BOARD.
OR TERMINAL No.

DUAL SWEEP TYPE S2A
A SWEEP GENERATOR P.C.132
FIG. 2.

RESISTORS	259 261	251	252	253	254 258	255	256	257
CAPACITORS							251 252 253	254 255 256 257
MISC.	S251							



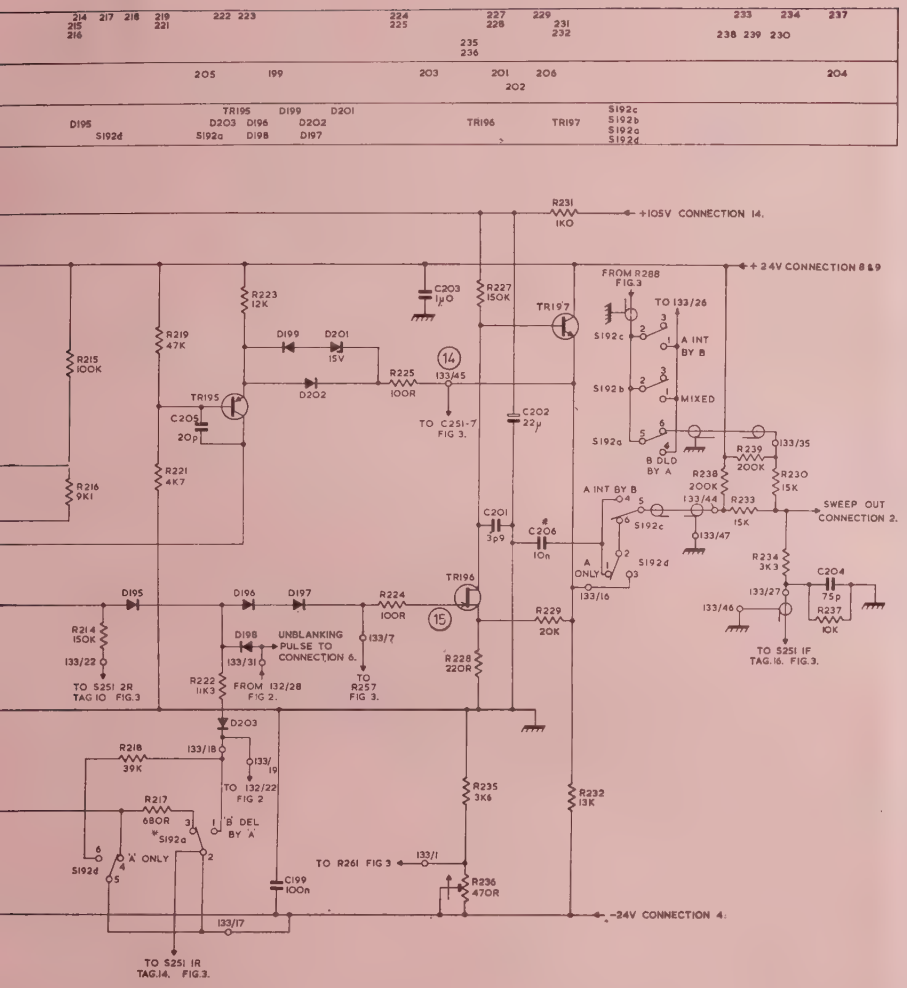
B TIME/DIV. SWITCH S2A
FIG. 3.



A TIME/DIV. SWITCH S2A
FIG. 3.

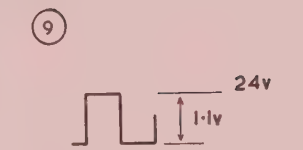
| | | |

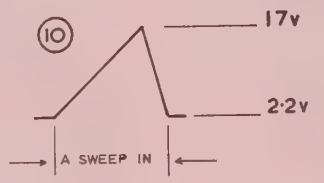
| | | |

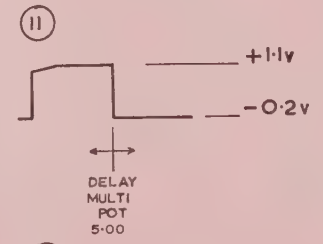


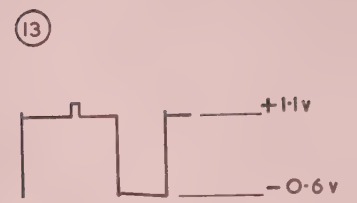
NOT MOUNTED ON P.C. BOARD.
/EYELET OR TERMINAL No.

DUAL SWEEP TYPE S2A
'B' SWEEP GENERATOR P.C.133
FIG. 5.









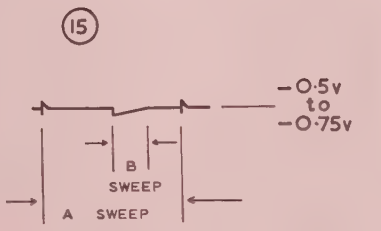
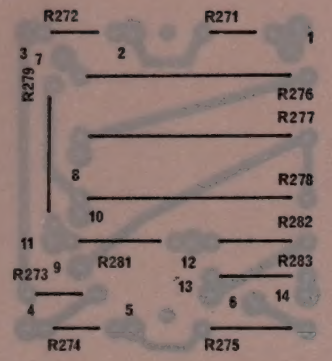


PLATE 6/2

LOCATION OF COMPONENTS ON PRINTED CIRCUIT BOARDS

Cir Ref	Grid Location	Cir Ref	Grid Location	Cir Ref	Grid Location	Cir Ref	Grid Location	Cir Ref	Grid Location	Cir Ref	Grid Location	Cir Ref	Grid Location	Cir Ref	Grid Location
C1	6—D1					R7	6—E1	R72	6—F2	R151	6—G6	R211	6—F4	R277	6—A2	TR5	6—E3
C2	6—F2					R8	6—E2	R73	6—F2	R152	6—G6	R212	6—F4	R278	6—A2	TR6	6—F3
C3	6—D2					R9	6—E2	R74	6—F2	R153	S153	R213	6—F4	R279	6—A1	TR7	6—F3
C4	6—D2	C192	6—E4	D61	6—F2	R10	6—E2	R75	6—F3	R154	6—H5	R214	6—F4				
				D62	6—F1	R11	6—D3	R76	6—G3	R155	6—G5	R215	6—F4	R281	6—A1		
C6	6—E1	C194	6—E4	D63	6—F2	R12	6—D5	R77	6—G3	R156	6—G5	R216	6—F4	R282	6—B2		
C7	6—E2	C195	6—F4	D64	6—F2	R13	6—D2	R78	6—G3	R157	6—F5	R217		R283	6—B2	TR61	6—E1
C8	6—D2	C196	6—E4	D65	6—G3	R14	6—D3	R79	6—G3	R158	6—F5	R218		R284		TR62	6—E1
C9	6—E2	C197		D66	6—G3	R15	6—D2			R159	6—G5	R219	6—G4	R285		TR63	6—G3
		C198	6—F4	D67	6—G3	R16	6—E2	R81	6—G2					R286		TR64	6—G3
C11	6—D2	C199	6—D4	D68	6—H3	R17	6—E2	R82	6—G2	R161	6—F5	R221	6—G4	R278		TR65	6—G2
C12	6—E3	C201	6—H4	D69	6—H3	R18	6—E2	R83	6—G2	R162	6—F6	R222	6—G4			TR66	6—H2
C13	6—E3	C202	6—D5			R19	6—E2	R84	6—G3	R163	6—G5	R223	6—F4	R289		TR67	6—H2
C14	6—E3	C203	6—D4	D71	6—H3			R85	6—G2	R164	6—G5	R224	6—H5			TR68	6—G1
C15	6—F3	C204	6—D4	D72	6—G2	R21	6—D1	R86	6—G3	R165	6—F5	R225	6—G4			TR69	6—G1
				D73	6—H1	R22		R87	6—G2	R166	6—F5						
				D74	6—G1	R23	6—D2	R88	6—G2	R167	6—F5	R227	6—G4	S1	'A' Source		
C61	6—F2			D75	6—G2	R24	6—E3	R89	6—G3	R168	6—F5	R228	6—H4	S2	'A' Polarity		
C62	6—F1	C251		D76	6—G2	R25	6—E2			R169	6—F5	R229	6—H4	S3	Trig Mode	TR151	6—G5
C63	6—E1	C252				R26	6—E2	R91	6—E2							TR152	6—G5
C64	6—F3	C253	'B'			R27	6—E3	R92	6—H3	R171	6—F6	R231	6—D5			TR153	6—F5
C65	6—G3	C254	T/D			R28	6—E3	R93	6—H3	R172	6—F5	R232	6—G4			TR154	6—F5
C66	6—G3	C255	Switch	D193	6—F4	R29	6—D2	R94	6—H2	R173	6—E6	R233	6—D4	S61	Rep	TR155	6—F5
C67	6—G3	C256		D194	6—F4			R95	6—H3	R174	6—F5	R234	6—D4	S62	Reset		
C68	6—G3	C257		D195	6—G4	R31	6—D2	R96	6—H2	R175	6—F5	R235	6—H4				
				D196	6—G4	R32	6—E3	R97	6—H2	R176	6—E6	R236	6—G4			TR191	6—E4
				D197	6—G5	R33	6—E3	R98	6—G2	R177	6—E6	R237	6—D4				
C71	6—G2	C271		D198	6—G4	R34	6—E3	R99	6—H2					S151	'B' Source	TR192	6—E4
C72	6—G2	C272		D199	6—G4	R35	6—E3							S152	'B' Polarity	TR193	6—E4
		C273				R36	6—F2	R101	6—G1					S153	'B' Auto	TR194	6—F4
C74	6—H2	C274		D201	6—G4			R102	6—G2	R191	6—E4	R251				TR195	6—G4
C75	6—G1	C275	'A'	D202	6—G4	R38	6—F3	R103	6—H1	R192	6—E4	R252				TR196	6—G4
C76	6—G1	C276	T/D	D203	6—G4	R39	6—F3	R104	6—G1	R193	6—E4	R253	'B'			TR197	6—H4
C77	6—G2	C277	Switch					R105	6—G1	R194	6—E4	R254	T/D	S191	Delay		
C78	6—H1	C278				R41	6—F3	R106	6—G1	R195	6—E4	R255	Switch	S192	Sweep Select		
C79	6—G1	C279				R42	6—F3	R107	6—G1	R196	6—E4	R256					
				L1		R43	6—F3	R108	6—F1	R197	6—G4	R257					
C81	6—F1	C281						R109	6—G1	R198	6—G4	R258					
		C282								R199		R259		S251	'B' Time/Div		
								R111	6—G1	R200							
				L61	6—F3	R62	6—F1	R112	6—G2	R201	6—H5	R261					
C151	6—G6					R63	6—E2	R113	6—F1	R202	6—H5						
C152	6—G6	D1	6—E1			R64	6—F1	R114	6—G2	R203	6—E5			S271	'A' Time/Div		
C153	6—G6	D2	6—E2			R65	6—E1	R115	6—F1	R204	6—E5						
C154	6—G5	D3	6—D5	R3	6—E1	R66	6—E1	R116	6—F1	R205	6—E4	R271	6—A1				
C155	6—G5	D4	6—E2	R1	6—E1	R67	6—E1	R117	6—F1	R206	6—E4	R272	6—A1				
C156	6—G5	D5	6—D3	R2	6—E2	R68	6—D1	R118	6—F1	R207	6—F4	R273	6—A2	TR1	6—E2		
C157	6—F5	D6	6—D3	R4	6—E2	R69	6—G3			R208	6—F4	R274	6—A2	TR2	6—E2		
C158	6—F5	D7	6—F3	R5	6—E2					R209	6—F4	R275	6—B2	TR3	6—E2		
C159	6—F6	D8	6—D5	R6	6—E1	R71	6—G2					R276	6—A1	TR4	6—E3		



Ref. Figure 2
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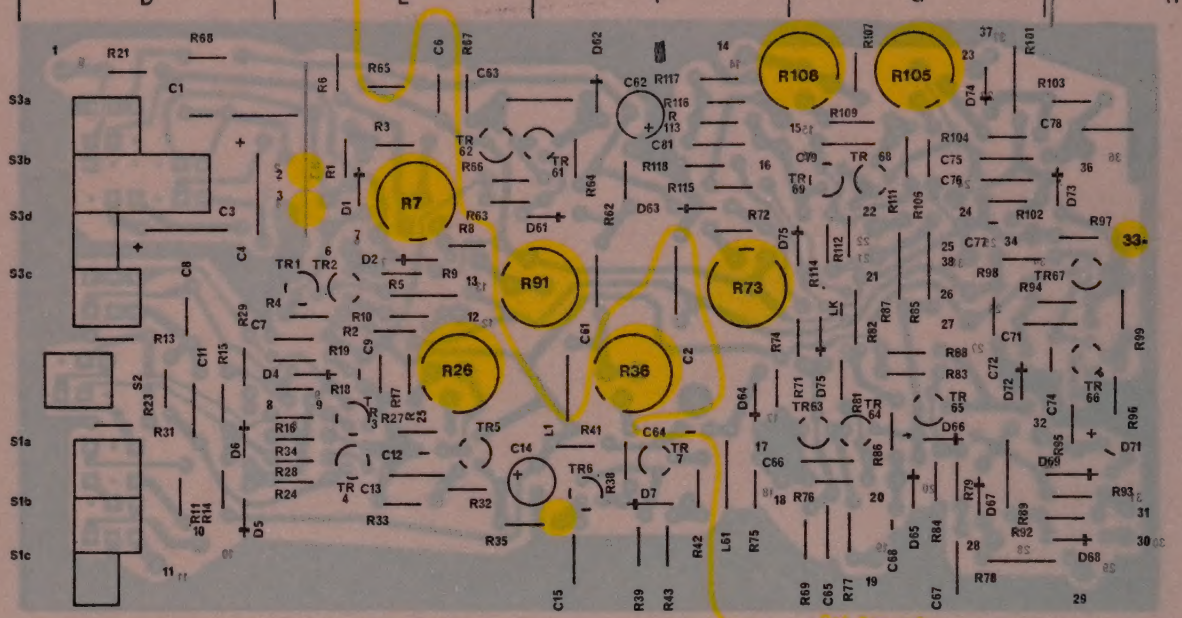
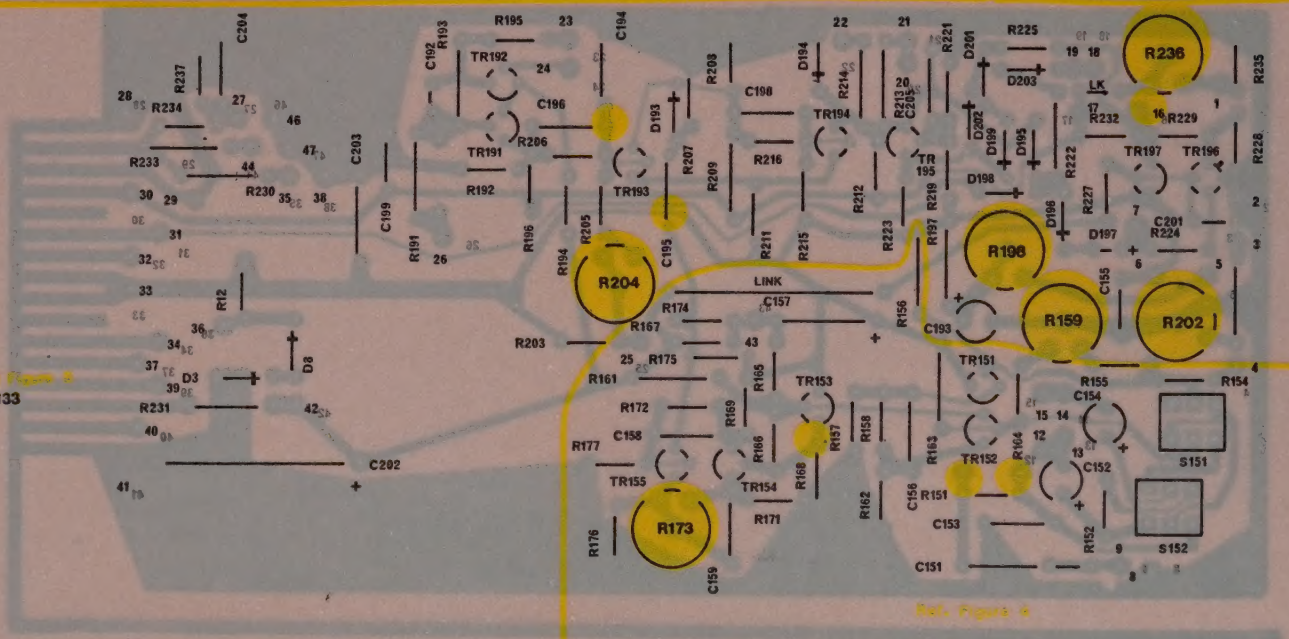


Ref. Figure 1
PC132

Ref. Figure 3

Ref. Figure 4



Ref. Figure 5
PC133

Figure 6
COMPONENT
REFERENCE

COMPONENT REFERENCE

Figure 9

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